A MANUAL OF THE DISSECTION OF THE HUMAN BODY.

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A MANUAL

OF THE

DISSECTION

OF THE

HUMAN BODY.

BY

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TO THE

STUDENTS

OF

ST. BARTHOLOMEW'S HOSPITAL,

IN THE HOPE

THAT IT MAY ASSIST THEM IN THEIR ANATOMICAL STUDIES,

THIS MANUAL IS DEDICATED

BY THEIR FAITHFUL FRIEND AND SERVANT,

THE AUTHOR.

PREFACE.

If any apology be needed for the appearance of the present Manual, it may be stated, without any wish to disparage the labours of others, that the works of this kind hitherto published seem to the Author open to one or the other of two objections:—either as being too systematic, and therefore not adapted for the dissecting-room, or as obscuring the more important features of anatomy by a multiplicity of minute and variable details.

In endeavouring to supply a presumed deficiency, the Author has made it his special aim to direct the attention of the student to the prominent facts of anatomy, and to teach him the groundwork of the science; to trace the connexion, and to point out the relative situation of parts, without perplexing him with minute descriptions.

A concise and accurate account is given of all the parts of the human body, the bones excepted, of which a competent knowledge is presupposed; and directions are laid down for the best method of dissecting it.

The several regions of the body are treated of in the order considered most suitable for their examination; and the muscles, vessels, nerves, &c. are described, as they are successively exposed to view in the process of dissection.

The arrangement by numbered paragraphs and subdivisions has been adopted to facilitate reference.

It is intended to publish the work in Four Parts, comprising the Dissection of the Arm, that of the Head and Neck, the Abdomen and Pelvis, and the Leg, respectively.

The Author has written the work entirely from actual observation: at the same time no available sources of information have been neglected, the highest authorities both English and Foreign having been carefully consulted. His acknowledgments are especially due to F. C. Skey, Esq. F.R.S. Lecturer on Anatomy at St. Bartholomew's Hospital, for many valuable suggestions. He is also much indebted to his young friend, Mr. W. Clubbe, for able assistance in dissections.

ERRATA.

Page		line				
71	...	1	*for*	"50°,"	*read*	60°.
95	...	2	...	"surgical,"	...	anatomical.
115	...	14	...	"axis,"	...	atlas.
				"atlas,"	...	axis.
118	...	last	...	"hyoid,"	...	thyroid.
138	...	25	...	"nerve,"	...	name.
178	...	32	...	"glaseri,"	...	Glasseri.
223	...	10	...	"heart,"	...	right.
439	...	1	...	"internal,"	...	external.
507	...	16	...	"vertebral,"	...	basilar.
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A

MANUAL

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DISSECTION OF THE HUMAN BODY.

THE DISSECTION OF THE ARM.

1. The arm being placed at a right angle with the body, let three incisions, not dividing more than the thickness of the skin, be made in the following directions. The first, along the front of the sternum from its upper to its lower end; the second, along the whole length of the clavicle; the third, commencing at the lower end of the sternum, should be continued outwards for four inches, and thence upwards along the front border of the axilla to the arm.

The skin should be carefully separated from the subjacent layer of adipose and cellular tissue, usually called the *superficial fascia,* a structure which exists, in greater or less development, over nearly the whole of the body. It consists of fibro-cellular tissue, containing within its cells a variable quantity of fat, and is intimately united to the skin by a number of fibrous processes, but more loosely connected to the parts beneath, so that the skin is enabled to move freely over them.

From the superficial fascia over the front of the chest arises a broad cutaneous muscle, called the *Platysma myoides.* It consists of thin, pale, and sometimes scarcely perceptible muscular fibres, which ascend over the clavicle, and are continued along the side of the neck, to the lower jaw and the cheek.

2. Numerous vessels and nerves ramify in the subcutaneous

tissue over the pectoralis major muscle, supplying the skin and the mammary gland. They are derived from various sources. Some of the nerves, branches of the superficial cervical plexus, descend over the clavicle: others, branches of the intercostal nerves, perforate the intercostal spaces, close to the sternum, each in company with a small artery; a third series, also branches of the intercostal nerves, come out on the side of the chest between the ribs, and run forwards over the outer border of the pectoralis major. These nerves are larger in the female than the male.

The *supra-clavicular*, the cutaneous nerves which descend over the clavicle, are subdivided according to their direction, into *sternal, clavicular,* and *acromial* branches.

The *sternal,* one or two in number, and of small size, cross the inner end of the clavicle, to supply the integument over the upper part of the sternum.

The *clavicular,* two or three in number, pass over the centre of the clavicle, and divide into filaments, which supply the integument over the front of the chest and the mammary gland.

The *acromial* branches, the largest, cross over the outer end of the clavicle, and distribute their filaments to the skin of the shoulder.

These several nerves are situated beneath the Platysma as they cross the clavicle, and are occasionally accompanied by small arteries.

3. The nerves which perforate the intercostal spaces, about half an inch from the sternum, will be readily found with the small arteries which accompany them. They are called the *anterior cutaneous branches of the intercostal nerves.* After traversing the fibres of the pectoralis major, each nerve sends a slender filament inwards to the skin over the sternum, and a larger filament outwards, which supplies the integuments over the pectoral muscle. The nerve which perforates the first intercostal space is the smallest. Those perforating the third, fourth, and fifth, are generally the largest, and supply the mammary gland.

The arteries which accompany these nerves are *perforating branches of the internal mammary.* One, or sometimes two, of them are transmitted through each intercostal space. They pass outwards, supplying the pectoral muscle, the skin, and the

mammary gland. The branches destined for the latter are larger than the rest, and, during lactation, increase in size, ramifying tortuously over the surface of the gland: in some instances they have been seen nearly as large as the radial at the wrist.

The cutaneous nerves which run forwards over the outer border of the pectoralis major, are derived from the *lateral cutaneous branches of the intercostal nerves,* which escape between the digitations of the serratus magnus on the side of the chest. They will be more fully described at a future stage of the dissection. (See § 12.)

The superficial fascia must now be removed with the mammary gland from the surface of the pectoralis major, which will be most easily cleaned by dissecting parallel to the course of its fibres. The muscle, like all others, is covered by a thin layer of condensed cellular membrane, which forms its proper fibrous investment, and sends down partitions between the larger bundles of muscular fibres. When the whole surface of the muscle has been fully exposed, observe its shape, the course of its fibres, their origin, and insertion.

4. The *pectoralis major* muscle, somewhat triangular in form, constitutes the prominence on the front of the chest of the male, and the anterior border of the axilla. It is divided into two distinct, but unequal portions, which are separated by a cellular interval. The upper and smaller portion, called clavicular, arises from the anterior surface of the sternal half of the clavicle. The lower and larger portion is attached to the front of the sternum, and to the cartilages of all the true ribs, except the first and the last: in some subjects, also, by a distinct slip to the aponeurosis of the external oblique muscle of the abdomen. Its sternal attachment consists, more especially at its lower part, of aponeurotic fibres, which, interlacing with those of the opposite side, form a fibrous layer in front of the sternum. The several bundles of muscular fibres converge towards the arm, and terminate in a flat tendon, about two inches in breadth, which is inserted into the anterior margin of the bicipital groove of the humerus. Their arrangement, as well as the structure of their tendon, is peculiar. The lower fibres, which are longer than the rest, ascend outwards, and are folded beneath the upper and

middle, so as to terminate upon the higher part of the tendon; whereas the upper fibres descend in an oblique direction, in front of the lower, and terminate upon the lower part of the tendon. Thus the upper and lower fibres of the muscle cross each other previously to their insertion.

The structure of the tendon can be best examined after the muscle is divided. It consists of two distinct layers, placed one in front of the other, and united inferiorly: the anterior layer receives the upper and middle fibres of the muscles; the posterior receives the lower.

The upper border of the posterior layer of the tendon sends off an aponeurotic expansion, which covers the long head of the biceps, and is attached to the great tuberosity of the humerus. The inferior border of the anterior layer is intimately connected with the fascia of the upper arm, and the tendon of the deltoid muscle.

The chief *action* of the pectoralis major is to draw the arm towards the chest: as, for instance, in placing the hand on the opposite shoulder, or in pulling an object towards the body. If the arm be elevated, and made the fixed point, the muscle will assist in raising the trunk, as in climbing. The peculiar arrangement of the muscular fibres, which we have noticed, serves the purpose of enabling all parts of the muscle to act simultaneously when the arm is extended.

Between the pectoralis major and the deltoid, the great muscle of the shoulder, there exists a *cellular interval* varying in extent in different subjects, but always more marked towards the clavicle. This fissure corresponds pretty nearly to the direction of the axillary artery. It contains a small artery—the *thoracica-humeraria*—and the *cephalic vein*, which, ascending along the outer side of the arm, empties itself into the axillary vein. In this interval, also, are usually found one or more small absorbent glands, called infra-clavicular: they receive the absorbent vessels which accompany the cephalic vein. These glands are situated most frequently near the clavicle, but are observed occasionally several inches lower down along the course of the vein.

5. Anatomy of the infra-clavicular region.—Reflect from the clavicle the clavicular portion of the pectoralis major. Care

should be taken not to divide a small artery and nerve which enter its under surface. The artery comes from the thoracic axis, and the nerve is a thoracic branch of the brachial plexus. Beneath the reflected portion of the muscle will be observed a tolerably compact fascia, which is attached to the clavicle, separates the two pectoral muscles, and is continuous below with the fascia of the axilla. Remove this fascia, together with some subjacent fat and cellular tissue, and part of the pectoralis minor will be exposed. Between the upper border of this muscle and the clavicle there exists an important space, in which the following objects will be observed:—

a. A strong ligamentous expansion, called the costo-coracoid ligament, which extends from the cartilage of the first rib to the ~~clavicle~~. Scapula

b. The axillary vein, artery, and plexus of nerves.

c. The subclavius muscle enclosed in its fibrous sheath.

d. A short arterial trunk, called the thoracic axis, which appears above the pectoralis minor, and divides into several branches, which take different directions.

e. The termination of the cephalic vein in the axillary.

f. Two or three nerves, called the anterior thoracic, which descend from the axillary plexus beneath the clavicle, cross in front of the axillary vessels, and subdivide into numerous filaments to supply the pectoral muscles.

These several objects must be carefully dissected and examined in detail.

6. The *costo-coracoid ligament or fascia* varies in density in different individuals. It extends from the cartilage of the first rib to the coracoid process, and between these two points it is attached to the clavicle, and forms a complete investment for the subclavius muscle. In front the ligament presents a crescent-shaped margin which arches over, and protects the axillary vessels and nerves: from this margin a fascia is prolonged, which accompanies the vessels into the axilla, enclosing them in a kind of sheath, especially strong on the inner side of the vein. This fascia must necessarily be divided before the axillary vessels can be exposed.

7. Immediately above the upper border of the pectoralis minor

Branches of Thoracic Ax. 1 Sup. or Short Thoracic
2 Thoracica Humeraria
3 " Acromialis
4 Br. to Subclavius

is seen a branch of the axillary artery, called the *thoracic axis.* It is a short thick trunk, which divides into several branches. One of these, called the *superior* or *short thoracic,* runs along the upper border of the pectoralis minor, between the two pectoral muscles, supplying ramifications to both, to the mammary gland, and inosculating with the intercostal and internal mammary arteries. A second branch, called the *thoracica humeraria,* descends by the side of the cephalic vein, in the groove between the pectoralis major and deltoid muscles, and ramifies in both. A third, the *thoracica acromialis,* passes over the coracoid process to the under surface of the deltoid, where it divides into several ramifications, some of which supply the deltoid muscle, communicating with the circumflex branches of the axillary artery; others, piercing the deltoid, maintain upon the upper surface of the acromion process an intricate anastomosis with corresponding branches of the supra-scapular and circumflex arteries. A fourth small branch occasionally proceeds inwards to the clavicle and subclavius muscle. All these arteries are accompanied by veins, which most frequently empty themselves into the cephalic previous to its termination in the axillary, but occasionally into the axillary vein itself.

8. The *cephalic vein* is one of the principal trunks formed by the cutaneous veins of the arm, the shoulder, and the chest. Commencing by roots from the dorsal surface of the thumb and fore-finger, it passes superficially along the radial side of the fore-arm over the front of the elbow-joint; thence ascending along the outer edge of the biceps muscle, it runs up the interval between the pectoralis major and deltoid muscles to reach the upper border of the pectoralis minor, where it crosses the axillary artery, and terminates in the axillary vein.

In the space now before us we observe the *great vessels and nerves of the axilla* in the first part of their course. Their depth from the surface will mainly depend upon the extent to which the clavicle projects. They are closely surrounded by a sheath of fascia, which descends with them beneath the clavicle, and are situated with regard to each other in the following manner. The axillary vein is the very large venous trunk in front of the artery, and rather to its sternal side; the vein, if distended, will partially con-

ceal the artery. The vessels are not in absolute contact, but separated by a thin membranous septum, derived from the costo-coracoid fascia. The plexus of nerves is situated above the vessel, and on a plane posterior to it. The plexus consists of two or sometimes three large cords, which result from the union of the anterior branches of the four last cervical nerves and the first dorsal.

9. The small nerves which cross more or less obliquely over the axillary artery immediately below the clavicle are called the *anterior thoracic* nerves. They arise from the front of the axillary plexus, beneath the clavicle, and supply the pectoral muscles. Two of them, branches of the fifth and sixth cervical, generally cross in front of the axillary artery and vein, and distribute their filaments along the under surface of the pectoralis major, in company with the branches of the thoracic axis which supply the muscle. A third, most commonly a branch of the eighth cervical, runs underneath the artery, and then coming forwards between it and the vein, communicates with one of the nerves in front, so as to form a kind of loop round the vessel. Its filaments enter the under surface of the pectoralis minor in company with an artery: one or two of them pass through the muscle to supply the pectoralis major.

A slender filament from the anterior thoracic nerves may sometimes be traced to the sternal joint of the clavicle, and another to the acromial joint.

10. The muscle which lies beneath the clavicle enclosed in a strong sheath is the *subclavius*. Open the sheath by an incision parallel to the clavicle, in order to expose the muscle. It *arises* from the junction of the cartilage with the osseous portion of the first rib by a round tendon, which extends for some distance along the inferior surface of the muscle. The fleshy fibres ascend over the subclavian vessels, and are *inserted* into a groove on the under surface of the clavicle as far outwards as the coraco-clavicular ligament.

The *action* of this muscle is to depress the clavicle, and prevent its too great elevation.

The *nerve to the subclavius* is a small branch of the brachial plexus. It usually comes from the fifth cervical nerve, runs in

front of the subclavian artery, and enters the centre of the muscle.

A small *bursa mucosa* is in some subjects found between the tendon of the subclavius and the first rib.

From the view which has been obtained of the relations of the axillary artery in the first part of its course, some idea may be formed of the difficulty of passing a ligature round the vessel in this situation. In addition to the ordinary obstacles, varieties sometimes occur in the position of the nerves and veins, which would render the operation still more embarrassing. For instance, the anterior thoracic nerves may be more numerous than usual, and form by their mutual communications a kind of plexus round the artery. It sometimes happens that a large nerve crosses obliquely in front of the artery immediately below the clavicle, and subsequently forms one of the roots of the median nerve.

The cephalic vein may ascend higher than usual, and open into the subclavian; and, since it frequently receives large veins corresponding to the thoracic arterial axis, a concourse of veins would in such cases be met with in front of the axillary artery.

Again, it is by no means uncommon to find one or more deeper-seated veins, which cross directly over the artery to join the axillary vein.

DISSECTION OF THE AXILLA.

Prolong the incision down the upper third of the arm, and reflect the skin from the axilla and from the side of the chest, taking care not to remove with it the dense subjacent membrane. In close contact with the skin, near the roots of the hair in the axilla, will be observed numerous sebaceous glands. They are of a reddish-brown colour, and rather larger than a pin's head.

11. The tough unyielding membrane which lies immediately beneath the skin of the axilla, is nothing more than a continuation of the general investment of the muscles. On account of its compactness, it has received the name of *the axillary fascia.*

This fascia closes in and forms, as it were, the floor of the cavity of the axilla. Externally it is intimately connected with the

tendons of the pectoralis major and latissimus dorsi, and between them it is continuous with the fascia on the inner side of the arm. Internally it is prolonged on the side of the chest, over the serratus magnus muscle. In front and behind, the fascia divides so as to enclose between its layers the respective muscles which form the anterior and posterior boundaries of the axilla. Thus the anterior layer is continued upwards beneath the two pectoral muscles, and is connected with the coracoid process, the costo-coracoid ligament, and the clavicle. The posterior layer, enclosing the latissimus dorsi muscle, passes backwards to the spines of the dorsal vertebræ.

12. Remove the axillary fascia. An artery, sometimes of considerable size, is often observed in its substance; it generally arises from the brachial, or, perhaps, the lower part of the axillary, and runs forwards across the floor of the axilla, and along the lower edge of the pectoral muscle. Though simply a subcutaneous artery, it might occasion considerable hæmorrhage if wounded in opening an abscess. The axilla contains a chain of absorbent glands, with a number of arteries, veins, and nerves, forming an intricate plexus, embedded in loose cellular tissue and fat. This cellular tissue should be broken down with the handle of the scalpel, in order to discover the nerves which cross from the ribs towards the posterior border of the axilla. These nerves are called the *lateral cutaneous branches of the intercostal nerves;* they perforate obliquely the intercostal spaces between the digitations of the serratus magnus, nearly midway between the sternum and the spine, each in company with a small branch of the corresponding intercostal artery, and then divide into anterior and posterior branches. The *anterior* turn over the pectoralis major, to supply the skin on the front of the chest and the mammary gland. The *posterior* pass backwards over the latissimus dorsi, and are distributed to the skin covering this muscle and the scapula.

13. The *perforating branch of the second intercostal nerve* requires a special description; it is much larger than the others, and is called the *intercosto-humeral nerve,* from its supplying the integuments of the arm. It comes through the second intercostal

space, close to the lower border of the second rib, above the third digitation of the serratus magnus, traverses the upper part of the axilla, where it receives a branch of the lesser internal cutaneous nerve, (nerve of Wrisberg, from the brachial plexus,) and perforating the fascia, terminates in numerous filaments, which are distributed to the skin, on the inner and posterior aspect of the arm, as low as the internal condyle. Before it leaves the axilla, this nerve sends a branch which turns round the latissimus dorsi, to supply the integument over the dorsum of the scapula.

The *perforating branch of the third intercostal* is also an *intercosto-humeral* nerve. It almost always receives a branch from the second, and has a somewhat similar distribution, except that its filaments do not extend so low down the arm.

14. The *axilla* may be described as a space, of somewhat conical form, of which the summit is beneath the clavicle, and the base between the pectoralis major and latissimus dorsi muscles. On the *inner* side, the axilla is bounded by the four or five upper ribs, covered by the serratus magnus muscle; on the *outer* side by the humerus, covered by the coraco-brachialis and biceps muscles; in front by the pectoralis major, and behind by the latissimus dorsi, teres major, and subscapularis muscles. Its anterior and posterior boundaries converge from the chest, so that the axilla becomes gradually narrower towards the arm.

This space, of which the dimensions vary with the position of the arm, is occupied by loose cellular tissue and fat, and by numerous *absorbent glands,* which form a continuous chain beneath the clavicle, with the cervical glands. They are from ten to twelve in number, of a reddish brown colour and variable size. Most of them lie in the immediate neighbourhood of some large blood-vessel; others are embedded promiscuously in the loose cellular tissue of the axilla, and sometimes one or two small ones are observed along the lower border of the pectoralis major, immediately beneath the skin. They are well supplied with blood by a special branch (*thoracica alaris*) of the axillary artery, as well as by numerous ramifications from the thoracic and infrascapular arteries.

These glands receive the absorbents from the arm, from the front

and side of the external parts of the chest, and from the outer half of the mammary gland.

The absorbent vessels which enter the glands, (*vasa inferentia*) are more numerous, but smaller than those which leave them (*vasa efferentia*). After forming a plexus around the subclavian vein, the latter vessels unite into a single trunk, which empties its contents on the left side into the thoracic duct, and on the right into the subclavian or internal jugular vein. The glands may be removed in order to expose other important objects.

The *great axillary vessels and nerves* occupy the upper part of the axilla, the axillary vein being the most conspicuous. A large artery is usually found on the side of the chest along the lower border of the pectoralis minor; it is the *inferior or long thoracic branch* of the axillary. Along the posterior border of the axilla will be seen another large artery, accompanied by a nerve, both called the *infra-scapular*, from their position.

Thus an artery of considerable size runs parallel with, and close to the anterior and posterior border of the axillary space; a point to be remembered in opening abscesses, or performing other operations in the axilla.

The broad flat muscle which covers the side of the chest between the ribs and the scapula, is called the *serratus magnus*, from the tooth-like appearance of its attachment to the eight superior ribs. Its fibres, converging, are inserted into the whole length of the posterior border of the scapula. This muscle, as well as others connected with the scapula, will be more fully examined hereafter.

15. On the external surface of the serratus magnus, observe a *large nerve called the posterior thoracic* (external respiratory of Bell).

This nerve, remarkable for the length of its course, is derived by two roots from the fifth and sixth cervical nerves, close to the transverse processes of the cervical vertebræ. Descending almost vertically behind the axillary vessels and nerves, it reaches the upper border of the serratus magnus, and runs down the external surface of this muscle to which its filaments are exclusively distributed,—each digitation usually receiving a separate filament.

The pectoralis major must now be divided midway between its

origin and insertion, and both ends reflected. After the reflection of the muscle, the peculiar arrangement of its fibres, and the structure of its tendon, should be more fully examined. (See § 4.)

On its under surface will be seen the branches of the thoracic arteries and nerves, which have been already described, § 7. The smaller arterial ramifications may be divided, but the main branches from which they arise should be preserved.

16. The *pectoralis minor* muscle, now exposed, *arises* by imperfect digitations from the osseous part of the third, fourth, and fifth ribs (not infrequently from the second), and sometimes from the glistening fascia covering the intercostal muscles. The fleshy fibres proceed upwards and outwards, and converge to a strong tendon, which is *inserted* into the anterior surface of the coracoid process of the scapula. This tendon is generally connected by a strong fascia to the upper part of the coraco-brachialis muscle; forming as it were a protection to the subjacent axillary vessels and nerves. A few of the lower fibres of the muscle are inserted into this fascia. The *action* of this muscle is to draw the scapula downwards and forwards.

In some instances a small *bursa* is found between the tendon of the pectoralis minor and the coracoid process.

The great muscle which forms the posterior margin of the axilla is the *latissimus dorsi.* Its extensive origin from the back cannot be seen. For present purposes, it is sufficient to notice its broad flat tendon, which passes behind the axillary vessels and nerves, and is inserted into the bicipital groove of the humerus.

Immediately behind the latissimus dorsi, and closely connected with it, is a muscle called the *teres major,* which also assists in forming the posterior boundary of the axilla. Its fleshy fibres *arise* from the lower angle of the dorsum of the scapula, pass nearly parallel to the latissimus dorsi, and terminate in a very broad tendon, which is *inserted* into the posterior margin of the bicipital groove of the humerus.

The muscle which occupies the internal surface of the scapula is called the *subscapularis.* It *arises* from the internal surface of the scapula, and terminates in a strong flat tendon, which passes under the axillary vessels and nerves, over the inner side of the

shoulder-joint, and is *inserted* into the lesser tuberosity of the humerus.

The two muscles which are attached to the coracoid process of the scapula, and descend perpendicularly along the inner side of the arm, are the *coraco-brachialis* and *short head of the biceps.*

Along the upper border of the pectoralis minor runs an artery,—the superior, or short thoracic; another, larger than the former, runs near the lower edge of the muscle, and is called the inferior, or long thoracic. They are both branches of the axillary.

Reflect the pectoralis minor from its origin, without dividing the thoracic arteries, and the cavity of the axilla will be completely exposed. The great vessels and nerves should be carefully cleaned, without disturbing their connexions. It is advantageous partially to reflect the subclavius from its attachment to the rib and the clavicle, in order to obtain a full view of the axillary plexus and vessels.

17. Course and relations of the axillary vessels and nerves.—The *axillary vessels* and *plexus of nerves* are closely covered by a thin layer of the cervical fascia, which descends with them beneath the clavicle. The direction of their course will necessarily vary with every position of the arm. The following description supposes the subject to be placed on the back, with the arm at nearly a right angle with the body. The main artery of the arm passes beneath the clavicle over the upper surface of the first rib, and is called the *subclavian* till it reaches the lower border of the rib, where it takes the name of *axillary.* These limits are merely arbitrary, and adopted for the convenience of description. From the margin of the rib *the axillary artery* proceeds obliquely downwards and outwards through the upper part of the axilla, beneath the two pectoral muscles, and along the inner edge of the coraco-brachialis muscle to the lower border of the tendon of the teres major muscle, where it takes the name of *brachial.* Thus the vessel crosses the apex of the axilla, and descends along its humeral side. In its course downwards, the artery lies successively over the first intercostal space and the second digitation of the serratus magnus; next upon the loose cellular tissue of the axilla; then upon the subscapularis muscle; and, lastly, upon the tendon of the latissimus dorsi and teres major.

The *axillary vein* in the first part of its course lies in front of

the artery, and to its sternal side: in the lower two-thirds of the axilla the vein still lies to the sternal side of the artery, but is separated from it by the nerves.

The axillary plexus, consisting of two or three large nerves, is at first situated above the artery, and on a plane posterior to it; but the nerves, as they descend, come into closer connexion with the artery, and subdivide in such a way, that, upon the tendon of the subscapular muscle the vessel is surrounded on every side by the interlacement of the nerves.

18. The *axillary* or *brachial plexus* is formed by the anterior branches of the four lower cervical nerves and the first dorsal. The plexus is broad at the lower part of the neck, where it appears between the scaleni muscles; but it gradually contracts as it descends beneath the clavicle, and across the apex of the axilla. The arrangement of the nerves in the formation of the plexus is by no means constant, and often dissimilar on both sides of the body. Most frequently the fifth and sixth cervical descend obliquely outwards, and unite to form a single large cord: the eighth cervical and the first dorsal also unite to form another; the seventh cervical runs for some distance alone, and then divides, so as to unite with the two other cords. Thus, the plexus, which at its commencement presents three large nerves, consists at the lower border of the first rib of only two; the one being situated behind the axillary artery, the other above it, and on its acromial side.

These two large nerves, by their subdivisions, form a plexus round the axillary artery, where it lies upon the tendon of the subscapularis, and give off the nerves to the arm in the following manner:—

The *median nerve* arises by two roots, which lie in front of the artery, and converge like the branches of the letter V. On the *outer side* of the artery is the external root of the median, and the external cutaneous nerve; on its *inner side* is the internal root of the median, the ulnar, and the internal cutaneous: *behind* the artery is the circumflex, and the musculo-spiral or radial nerve.

From this arrangement there are occasional deviations. For instance, the two roots of the median may embrace the artery, higher up in its course, or lower down than usual: or both its roots may lie behind the artery.

A deviation, one which was observed once only in 300 arms, may occur, in which all the nerves are situated above the artery, and on its acromial side, the vessel being entirely free in the whole of its course.

19. Replace the pectoralis minor, for the purpose of tracing the *branches of the axillary artery.* Their number and origin frequently vary, but their general course is in most cases similar; they usually arise from the axillary trunk in the order in which they are here described:—

The *thoracic axis* arises above the pectoralis minor, and divides into branches which have been already noticed, § 7.

The *inferior* or *long thoracic artery,* sometimes called the external mammary, descends almost vertically along the inferior border of the pectoralis minor. Its numerous ramifications supply the mammary gland, the serratus magnus and pectoral muscles, and maintain a free anastomosis with the branches of the superior thoracic, the internal mammary, and intercostal arteries. It sometimes arises by a common trunk with the following:—

20. The *infra-scapular artery* is the largest branch of the axillary; it arises opposite the lower border of the subscapular muscle, parallel to which it descends, and about one inch and a half from its origin, divides into an *anterior* and a *posterior* branch.

The *anterior branch* appears like the continued trunk; it takes rather a tortuous course along the anterior edge of the subscapularis muscle towards the inferior angle of the scapula. The numerous branches given off by this artery supply the subscapular, the latissimus dorsi, and serratus magnus muscles, and anastomose with the intercostal and thoracic arteries, as well as the posterior scapular (a branch of the subclavian).

The *posterior branch* (dorsalis scapulæ), larger than the preceding, turns round the lower border of the subscapularis, through a triangular opening bounded by the long head of the triceps, the teres major, and subscapularis muscles. Having reached the dorsum of the scapula, it divides into several branches, which ramify close upon the bone, supplying the infra-spinatus and teres minor muscles, and inosculating with the supra and posterior scapular arteries. The dorsalis scapulæ sends off a small branch, which ramifies in the sub-

Branches of Axillary Artery
1 Thoracic Axis
2 Inf. or Long Thoracic
3 Subscapular
4 Posterior Circumflex
5 Anterior
[illegible]

scapular muscle. The *infra-scapular vein* lies in front of its corresponding artery, and empties itself into the axillary vein.

21. Three *nerves*, called the *subscapular*, are found on the surface of the subscapularis muscle. They come from the posterior part of the axillary plexus, and supply respectively the latissimus dorsi, teres major, and subscapularis. The *nerve for the latissimus dorsi*, commonly called the *long subscapular*, is seen in company with the anterior branch of the infra-scapular artery. It runs behind the axillary vessels, and crosses obliquely the infra-scapular artery to reach the internal surface of the latissimus dorsi, which it enters by two or three branches. The long subscapular very rarely sends filaments to the serratus magnus.

The *nerve for the teres major* muscle is either a branch of the preceding, or a distinct one from the plexus. It lies nearer to the humerus than the long subscapular, and enters the upper surface of the muscle.

The proper *nerve for the subscapular muscle* arises from the plexus higher than the others, and enters the upper and posterior part of the muscle. Sometimes two or even more separate nerves are distributed to this muscle, especially in those instances in which it is divided by well-marked tendinous septa.

The origin of the subscapular nerves is apt to vary. The nerve for the teres major may be a branch of the long subscapular, or both may be derived from the circumflex nerve.

22. There are two *circumflex arteries*—an *anterior* and a *posterior*, so called from the manner in which they encircle the neck of the humerus. The *posterior circumflex artery* is nearly as large as the infra-scapular, close to which it is given off; or they may both arise by a common trunk from the axillary. It passes backwards through a quadrilateral opening, bounded above by the subscapularis muscle, below by the teres major, externally by the neck of the humerus, and internally by the long head of the triceps. It then winds round the back of the neck of the humerus, and reaches the under surface of the deltoid muscle, to which it is principally distributed.

This artery, in its course, supplies the long head of the triceps, the head of the humerus, and the capsule of the shoulder-joint. It

inosculates above with the acromial thoracic artery, below with the ascending branch of the superior profunda (a branch of the brachial), and in front with the anterior circumflex artery. In some instances, the posterior circumflex is a branch of the brachial, and ascends behind the tendons of the latissimus dorsi and teres major muscles to reach the deltoid.

The posterior circumflex artery is accompanied by the *circumflex nerve,* which will be found behind the axillary artery. This large nerve comes from the posterior part of the brachial plexus, in common with the musculo-spiral, and, after sending a branch to the subscapularis muscle, and another to the teres minor, terminates in the under surface of the deltoid. The nerve supplies, also, the skin covering the deltoid by one or more branches, which turn round the posterior border of the muscle, and subdivide into smaller filaments: one or two slender ones sometimes perforate the muscle to reach the skin.

The circumflex nerve sends small filaments to the capsule of the shoulder-joint, and to the head of the humerus through the foramina in the bone.

23. The *anterior circumflex artery,* a branch of the axillary, is very much smaller than the posterior, and will be found covered by a thin layer of fascia, in front of the neck of the humerus, immediately above the tendon of the latissimus dorsi. It proceeds directly outwards beneath the coraco-brachialis and short head of the biceps, close to the bone, and terminates in the under surface of the deltoid, where it inosculates with the posterior circumflex artery.

The most remarkable branch of the anterior circumflex artery, and one of the most constant in the body, is that which runs with the long tendon of the biceps up the groove of the humerus. It is called, on that account, the bicipital artery; it supplies the shoulder-joint, and gives off numerous branches, which form a plexus on the periosteum over the neck of the humerus, and penetrate the foramina in the bone. Branches from the anterior circumflex descend to inosculate with ascending branches of the superior profunda.

The *alar thoracic artery* is a small branch, variable in its origin.

It may come from the axillary, or the infra-scapular, or the inferior thoracic. It ramifies in the cellular tissue of the axilla, supplying the axillary glands.

24. The *axillary vein* is formed by the junction of the *venæ comites* of the brachial artery, near the anterior border of the subscapularis muscle. It receives the subscapular and the other veins corresponding to the branches of the axillary artery, with the exception of the circumflex, which usually join, either the subscapular, or one of the venæ comites. The axillary also receives the cephalic, and sometimes the basilic veins.

DISSECTION OF THE UPPER ARM.

25. Let the incision through the skin be continued down the arm over the front of the elbow to about two inches below it. Reflect the skin from the front and sides of the arm without removing the adipose and cellular tissue in which the subcutaneous nerves and veins ramify. The cutaneous nerves which perforate the fascia on the inner side of the arm are branches of the intercosto-humeral, and the greater and lesser internal cutaneous nerves.

The filaments of the *intercosto-humeral nerves* may be traced down the inner and posterior part of the arm to the olecranon.

The branches of the *internal cutaneous nerve,* two or more in number, perforate the fascia in one or two places about the middle of the inner side of the arm, and subdivide into two sets of filaments, of which the one supplies the anterior, the other the posterior surface of the fore-arm.

The *lesser internal cutaneous,* or *nerve of Wrisberg,* perforates the fascia about the lower third of the arm, and ramifies over the internal condyle and olecranon. All these cutaneous nerves have frequent communications with each other.

The *internal cutaneous branch of the musculo-spiral* nerve is sometimes wanting, and always small. It is usually accompanied by a small artery, and pierces the fascia near the middle of the inner side of the arm.

The nerves, one or more, which perforate the fascia near the middle of the outer part of the arm, are the *external cutaneous branches of the musculo-spiral.* They are generally accompanied by a small artery from the superior profunda. They divide into numerous filaments, one or more of which will be traced down the outer and back part of the forearm to the wrist.

In some instances this nerve sends cutaneous filaments upwards and downwards in company with the cephalic vein.

On the outer side of the tendon of the biceps, immediately above the elbow-joint, the *external cutaneous* nerve perforates the fascia, and divides into many branches, which supply the skin of the outer part of the forearm.

26. The next object of attention should be the *disposition of the veins in front of the elbow,* where venesection is usually performed. In cleaning these veins, great care should be taken not to divide the branches of the internal and external cutaneous nerves which pass both above and below them.

The following is the ordinary arrangement of the superficial venous plexus at the bend of the elbow, but it is subject to frequent varieties:—On the outer side of the fore-arm is the radial, and on the inner side is the ulnar vein; in the centre is a third, called the median, which divides into two branches; the external one, which unites with the radial to form the cephalic vein, is called the median cephalic; the internal one, which unites with the ulnar to form the basilic, is named the median basilic vein. Near the point of its bifurcation, the median vein communicates by one or more branches with the deep veins which accompany the arteries of the forearm.

Trace the *cephalic vein* up the arm. It runs superficially along the outer border of the biceps to the groove between the pectoralis major and the deltoid muscles, where it terminates in the axillary.

The *basilic vein* ascends along the inner side of the arm in company with the internal cutaneous nerve, which usually lies close to its outer side. Near the middle or the upper third of the arm, it perforates the fascia, and empties itself either into the internal vena comes of the brachial artery or into the axillary vein. In their course along the upper arm, the basilic and cephalic receive nume-

rous cutaneous veins, and the basilic has frequent communications with the deep brachial veins.

27. *The relative position of the internal and external cutaneous nerves with regard to the veins* at the bend of the arm is subject to some irregularity. Most commonly the trunks of the nerves pass beneath the veins, but often, though the principal branches go beneath the vessels, many small filaments cross in front of them which are exposed to injury in venesection.

The internal cutaneous nerve certainly passes more frequently superficial to the vein than the external. The external cutaneous nerve has been seen passing through a distinct foramen in the median cephalic vein.

Since the median basilic vein is generally larger than the median cephalic, and, on account of the strong fascia beneath, more easily compressible, it is usually chosen for venesection: its position, therefore, in reference to the brachial artery, becomes very important. The vein crosses obliquely in front of the artery, from which it is only separated by the fascia derived from the tendon of the biceps. This fascia is in some subjects remarkably thin, or it may be altogether wanting.

It sometimes happens that the brachial artery, or the radial, lies above the fascia, in absolute contact with the median basilic vein. In choosing, therefore, this vein for venesection, there is a risk of wounding the artery: hence the practical rule, to bleed either from the median cephalic, or at any rate from the median basilic above or below the situation where it crosses the brachial artery.

Immediately above the internal condyle, in the neighbourhood of the basilic vein, are usually found one or two small *subcutaneous absorbent glands*. One or two others may lie higher up along the inner side of the arm. A superficial gland has also been seen at the bend of the elbow: none are found below this joint. These little glands on the inner side of the arm are generally the first which become tender and enlarged after an injury to the hand.

Remove the superficial fascia in order to examine the proper investing fascia of the upper arm. Preserve the chief cutaneous veins and nerves.

28. The *dense aponeurosis which invests the upper arm* may be

considered as a continuation of the fascia from the trunk and the axilla; it is composed of circular fibres, intersected by others which have a vertical direction. This membrane varies in density: thus it is thin over the biceps muscle, stronger on the inner side of the arm, for the purpose of protecting the brachial vessels and nerves, and strongest over the triceps muscle. At the upper part of the arm the fascia is connected with the coracoid process and coraco-clavicular ligament: it is strengthened as it descends by an expansion from the tendons of the pectoralis major and latissimus dorsi: posteriorly it is firmly attached to the spine of the scapula and to its axillary border. The fascia surrounds the brachial vessels with a sheath, and sends off prolongations to separate the muscles from each other. Of these processes the most marked are those called the *external* and *internal intermuscular septa,* which divide the muscles on the anterior from that on the posterior surface of the upper arm. These septa are attached to the projecting ridges on either side of the humerus and to the condyles. The *internal septum,* the most prominent of the two, begins at the insertion of the coraco-brachialis, and separates the triceps extensor from the brachialis anticus muscles. The *external septum* commences from the insertion of the deltoid, and separates the brachialis anticus, the supinator longus, and the extensor carpi radialis longior in front, from the triceps behind.

At the lower part of the upper arm the fascia is remarkably strong, especially where it covers the brachialis anticus and the brachial vessels, and is continued over the muscles on the inner side of the forearm. At the back of the elbow, the fascia is attached to the tendon of the triceps and the olecranon.

The fascia must now be removed from the surface of the muscles, to which it is united by a very loose cellular tissue, which allows them to move freely beneath it. The nerves which pass through the fascia should be preserved.

The three muscles on the front of the arm should next be examined: these are, the biceps in front, above and on its inner side the coraco-brachialis, and beneath it the brachialis anticus.

29. The *biceps* is the long delicate-looking muscle which forms

the prominence on the front of the arm : as its name implies, it has two distinct origins or heads—a long and a short. The *short head of the biceps,* the most internal of the two, is attached to the point of the coracoid process of the scapula, by means of a flat tendon, from the posterior surface of which the fleshy fibres arise. This tendon is common to a slender muscle on its inner side, called the coraco-brachialis. The *origin of the long head* of the biceps cannot at present be seen; it takes place from the upper border of the glenoid cavity of the scapula by a long flat tendon, which traverses the shoulder-joint and passes over the head of the humerus, and between the two tuberosities. The tendon is retained in the groove by a strong fibrous expansion, derived from the capsule of the joint, and connected with the tendon of the pectoralis major. By dividing this expansion, it will be found that the synovial membrane of the joint is reflected round the tendon, and accompanies it for about two inches down the groove, thus forming a sort of synovial fold, between the layers of which small ramifications of the anterior circumflex artery run up to supply the tendon. The long tendinous head expands as it descends, and gives origin to the muscular fibres from its under surface. The two heads unite about the middle of the arm, or, perhaps, its inferior third, and form a single muscle, which terminates a little above the elbow-joint in a strong flat tendon of considerable length, which sinks deep into the triangular space at the bend of the elbow, and, after a slight twist upon itself, is *inserted* by a broad expansion into the posterior part of the tubercle of the radius. The anterior part of the tubercle, over which the tendon plays, is crusted with fibro-cartilage, and a large *bursa mucosa* intervenes to facilitate its motion. The most internal fibres of the muscle are connected with a *very strong broad aponeurosis, of a semilunar form,* which is prolonged from the inner border of the tendon obliquely downwards and inwards to the fascia of the forearm. This aponeurosis, commonly called the *semilunar fascia of the biceps,* protects the brachial vessels and the median nerve at the bend of the elbow.

At the upper part of the arm the two heads of the muscle are separated from each other by an interval, which will vary in extent

in proportion to the degree in which the humerus is rotated outwards. On the other hand, when the humerus is rotated inwards, the short head rather overlaps the long one. The action of the biceps is to bend the forearm. The insertion of its tendon into the posterior part of the radius gives it the power of supinating the hand,—a power which is greatly increased when the arm is bent.

30. The *coraco-brachialis* is a thin muscle, situated at the upper part of the arm, and runs parallel to the inner border of the short head of the biceps. It *arises* by fleshy fibres from the point of the coracoid process, in common with the short head of the biceps, and from a fibrous septum which lies between them. The muscle descends on the outer side of the brachial vessels and nerves, and terminates in a flat tendon, which is *inserted* into the inner side of the humerus, about its middle, between the brachialis anticus and the inner head of the triceps. This tendon is intimately connected with the internal intermuscular septum.

The coraco-brachialis is usually perforated from above downwards by the external cutaneous nerve.

This muscle and the biceps are covered at their upper part by the deltoid and great pectoral muscles. The head of the humerus rolls beneath the coraco-brachialis and short origin of the biceps, and a large *bursa mucosa* is usually interposed between these muscles and the tendon of the subscapularis, which covers the head of the bone. From the outer side of the coraco-brachialis a strong aponeurosis is prolonged beneath the deltoid over the shoulder-joint. Not infrequently some of the muscular fibres of the coraco-brachialis are inserted into the fascia, which covers the brachial artery in the centre of the arm. The *action of the muscle* is to draw the arm forwards and inwards towards the chest.

31. The *brachialis anticus*, partly concealed by the biceps, is situated along the front of the lower half of the humerus in close contact with the bone. To see the muscle the biceps must be raised by dissecting along its outer border. Between the two muscles will be found a layer of fascia and the external cutaneous nerve, of which the muscular branches must be preserved.

It *arises* about the middle of the humerus by a fleshy digitation

on either side the tendon of the deltoid, from the whole of the front surface of the bone below this point, and from the intermuscular septa. The muscle, necessarily becoming thicker and broader as it descends, covers the inner two-thirds of the front surface of the capsule of the elbow-joint, and terminates in a tendon, which appears on its anterior surface, and is *inserted* in a pointed manner into a rough surface below the coronoid process of the ulna.

Some of its deep muscular fibres are intimately connected with the capsule of the elbow-joint.

The tendon of the muscle is strongest on its external side, and gives origin to the fascia on the outer side of the forearm.

Its *action* is to bend the forearm.

32. The COURSE AND RELATIONS OF THE BRACHIAL VESSELS AND NERVES should now be examined.

The *brachial artery*, a continuation of the axillary, takes its name at the lower border of the teres major muscle. It passes down the inner side of the arm, along the inner border of the coraco-brachialis and biceps muscles, to a triangular space in front of the elbow, where it divides into the radial and ulnar arteries.

Thus its direction corresponds with a line drawn from the anterior part of the axilla to the central point between the condyles of the humerus.

In the upper part of its course it is supported by the triceps muscle, (from which it is separated by the musculo-spiral nerve and superior profunda artery) : in the middle of the arm, it lies on the tendon of the coraco-brachialis, close to the bone; and in the lower part of its course it rests on the brachialis anticus.

The artery is accompanied by two veins, called the *venæ comites*, and the great median nerve, all of which are invested in a common sheath of fascia. The median nerve generally crosses very obliquely in front of the artery, lying near the axilla on the outer side, and near the elbow on the inner side of the vessel.

The ulnar nerve, situated internally, diverges from the artery as it descends, and is separated from it below by the internal intermuscular septum. Superficial to the artery, we find the internal

cutaneous nerve and the basilic vein, but both lie in some instances on its inner side. It should be particularly observed that the artery is more or less overlapped, in the first part of its course by the coraco-brachialis,—and lower down by the fleshy belly of the biceps; both of these muscles in their respective situations being the best guides to the vessel.

About the middle of the humerus, the artery lies to the extent of nearly two inches on the tendon of the coraco-brachialis, and is so close to the bone that it can here be effectually compressed; in this situation it is usually crossed very obliquely by the median nerve.

At the bend of the elbow the artery is protected by the strong aponeurotic expansion derived from the tendon of the biceps. It enters a triangular space, bounded by two of the muscles of the forearm, namely, by the pronator radii teres internally, and by the supinator radii longus externally. It sinks into the space, with the tendon of the biceps, to its outer side, and the median nerve to its inner side, and all three rest upon the brachialis anticus muscle. Opposite the coronoid process of the ulna it divides into the radial and ulnar arteries.

Two veins, of which the internal is usually the larger, lie in close contact with the brachial artery, and communicate at frequent intervals by transverse branches, sometimes in front of, sometimes behind the artery.

33. Previous to the examination of the branches of the brachial artery, it is advantageous to trace the trunks of the nerves of the upper arm, which are derived from the brachial plexus, near the tendon of the subscapularis.

The *median nerve* arises from the plexus by two roots, which converge in front of the axillary artery. The external root is derived from a trunk in common with the external cutaneous nerve, the internal root from a trunk in common with the ulnar and internal cutaneous nerve. In its course down the arm, the nerve is situated at first on the outer side of the brachial artery, between it and the coraco-brachialis muscle: about the middle of the arm the nerve crosses obliquely over the vessel, or perhaps beneath it, so that at the bend of the elbow it is found on the inner side of the artery, covered by the semilunar fascia from the biceps.

The median nerve does not supply any of the muscles in the upper arm, but it usually receives a branch from the external cutaneous about the middle of its course.

There are certain *varieties* relating to the roots of the median nerve, and its course in regard to the artery, with which it is necessary to be acquainted.

a. The roots may be increased in number by one on either side of the artery: or the internal root may be deficient.

b. They may vary in their position with regard to the artery; both may be situated behind the vessel, or one behind, and the other in front of it.

c. The nerve, formed in the usual manner, may be joined lower down by a large branch from the external cutaneous; such a case presents a junction of two large nerves in front of the brachial artery, in the middle of the arm.

d. The nerve in many cases crosses under, instead of over the artery.

e. The nerve sometimes runs parallel and external to the artery; or it may run parallel to, and in front of the artery.

In one hundred arms, the relative position of the nerve to the artery in its course down the arm was as follows:—

In 72, the nerve took the ordinary course.
,, 20, the nerve crossed obliquely under the artery.
,, 5, the nerve ran parallel and superficial to the artery.
,, 3, the nerve ran parallel and external to the artery.

34. The *external cutaneous nerve (musculo-cutaneus, or perforans Casserii,)* arises from the plexus by a common trunk with the external root of the median, on the outer side of the axillary artery. After passing for a short distance along the inner border of the coraco-brachialis, it perforates this muscle obliquely outwards, and then descends between the biceps and the brachialis anticus. A little above the elbow-joint, between the outer border of the tendon of the biceps and the supinator radii longus muscle, the nerve perforates the fascia, becomes subcutaneous, and passing under the median cephalic vein, divides into two principal branches, for the supply of the integuments of the forearm.

The external cutaneous nerve, in the upper part of its course,

sends branches to the coraco-brachialis and the short head of the biceps, and, as it descends between the biceps and brachialis anticus, it supplies several branches to each. It usually sends a communicating branch in the middle of the arm, to the median nerve.

A slender branch of the external cutaneous sometimes runs along the outer side of the brachial artery down to the elbow, and supplies the skin.

A filament has been traced into the foramen on the inner side of the humerus, in company with the nutrient artery of the medulla.

In some instances the external cutaneous nerve descends on the inner side of the coraco-brachialis without perforating the muscle: in these cases it often sends a larger branch than usual to the median nerve.

The trunk of the external cutaneous nerve may come from the median at any point between the axilla and the middle of the arm. In some subjects the nerve is absent,—all its branches are then supplied by the median, which is larger than usual. Such anomalies are easily explained by the fact of the two nerves having always a common origin.

35. The *internal cutaneous nerve* is smaller than the external, and arises from the plexus by a common trunk with the ulnar and internal root of the median, on the inner side of the axillary artery. It descends on the inner side of the brachial artery, but more superficially. About the middle or the lower third of the arm it perforates the fascia, generally in company with the basilic vein, becomes subcutaneous, and divides into two or more principal branches, which run along the ulnar side of the fore-arm to the wrist. In its course down the arm, the internal cutaneous usually gives off one or two slender filaments, which supply the skin covering the biceps muscle.

A filament of the internal cutaneous nerve has been traced in company with a branch of the inferior profunda artery into the articular end of the humerus, immediately above the internal condyle.

In some rare instances, the internal cutaneous, at its origin, is situated on the outer side of the axillary artery; in such cases, it crosses over the brachial artery near the middle of the arm.

36. The *ulnar nerve,* one of considerable size, arises from the axillary plexus, in common with the internal cutaneous, and the inner root of the median. It descends along the inner side of the brachial artery, as far as the insertion of the coraco-brachialis. The nerve then diverges from the artery, perforates the internal intermuscular septum, and runs, in company with the inferior profunda artery, to the space between the internal condyle and the olecranon.

Between the internal condyle and the olecranon, the ulnar nerve lies upon the internal lateral ligament of the elbow-joint, from which it is sometimes separated by a *bursa* of small size. In two instances a communication has been seen between the bursa and the synovial capsule of the elbow-joint.

The ulnar nerve rarely gives any branches to the upper arm. In a few instances one or two slender filaments have been traced into the triceps muscle.

37. The *lesser internal cutaneous nerve (nerve of Wrisberg),* the smallest branch of the brachial plexus, assists the larger internal cutaneous in supplying the skin on the inner and posterior surface of the upper arm. It arises in connexion with the internal cutaneous nerve, receives a communication in the axilla from the intercosto-humeral, passes along the inner side of the brachial artery, perforates the fascia near the middle of the arm, and supplies the integuments over the internal condyle and the olecranon.

Previously to the examination of the musculo-spiral nerve it is well to have some knowledge of the great muscle which occupies nearly the whole of the posterior part of the humerus—viz. the *triceps:* to facilitate its dissection the fore-arm should be bent, and the strong fascia removed from the surface of the muscle.

38. The *triceps extensor cubiti* has three distinct origins or heads, named from their position the *external, internal,* and *middle* or *long* head. They are united to each other by loose cellular tissue, and may readily be seen on the inner side of the arm. The *middle* or *long* head will be found by dissecting below the head of the humerus immediately above the tendon of the latissimus dorsi; it arises by a strong flat tendon from the inferior border of the scapula, close to the glenoid cavity.

The *external* head will be found behind the insertion of the deltoid; its origin commences on the posterior part of the humerus, immediately below the great tuberosity, and extends down to the middle of the bone. The *internal* head arises from the posterior part of the humerus below the insertion of the teres major, and near that of the coraco-brachialis. The three heads of the muscle unite near the middle of the arm to form a single fleshy mass, which covers the posterior part of the elbow-joint, and is inserted by a thick tendon into the summit and sides of the olecranon. A more particular account of this muscle will be given hereafter.

39. The *musculo-spiral* or *radial*, the largest of the brachial nerves, arises, in common with the circumflex, from the posterior part of the axillary plexus. It descends behind the axillary artery over the tendon of the latissimus dorsi and the long head of the triceps, the latter of which it separates from the brachial artery. Near the middle of the arm the nerve winds obliquely round the posterior part of the humerus, between the external and internal heads of the triceps, in company with the superior profunda branch of the brachial artery. About the lower third of the outer side of the arm, the nerve will be found deeply embedded between the brachialis anticus and the supinator radii longus muscles. A little above the elbow-joint it divides into its two principal branches,—the *radial*, which accompanies the radial artery along the forearm,—and the *posterior muscular* (posterior interosseous of authors), which perforates the supinator brevis muscle on the outer side of the radius, and supplies the muscles on the back of the forearm.

The *musculo-spiral nerve gives off the following branches* :—

a. A small internal cutaneous branch, which perforates the fascia near the middle of the inner side of the arm, and assists in supplying the integuments over the lower part of the triceps : this nerve is occasionally absent.

b. One or two branches (each accompanied by an artery from the superior profunda) to each of the three divisions of the triceps muscle.

c. An external cutaneous branch, already dissected, which makes its way to the outer side of the arm, between the external head of the triceps and the upper part of the supinator longus. About the middle

of the arm it perforates the fascia, and divides into filaments some of which will be traced down the back of the forearm to the wrist.

d. Before its division the musculo-spiral nerve sends branches to the supinator longus, the extensor carpi radialis longior, and, in some few instances, to the brachialis anticus muscles.

A filament of the musculo-spiral nerve has been traced into one of the foramina in the humerus near the external condyle.

40. *The branches of the brachial artery should now be examined:* there are only three of importance, and all arise from its inner side; they are called the profunda superior, the profunda inferior, and the anastomotica magna.

The *profunda superior* arises from the inner and posterior part of the brachial artery, immediately below the tendon of the teres major muscle. It winds obliquely round the posterior part of the humerus, between the outer and inner heads of the triceps, in company with the musculo-spiral nerve, and a little above the middle of the arm divides into two branches, which run for some distance on either side of the nerve. One of these descends in the substance of the triceps to the olecranon, supplies the muscle and the elbow-joint, and anastomoses with the ulnar and interosseous recurrent arteries. The other branch accompanies the musculo-spiral nerve to the outer side of the arm, descends deep in the fissure between the brachialis anticus and supinator radii longus, and terminates in numerous ramifications, some of which pass in front of the external condyle, and others behind it, to inosculate with the radial and interosseous recurrent arteries.

Previously to its division the superior profunda sends off several branches to the coraco-brachialis and triceps muscles, some of which inosculate minutely with the circumflex and acromial thoracic arteries. These would assist in establishing a collateral circulation if the brachial artery were tied above the origin of its profunda branch.

41. The *profunda inferior* artery arises from the brachial, opposite to the insertion of the coraco-brachialis, or sometimes by a common trunk with the superior profunda. It pierces the intermuscular septum, in company with the ulnar nerve, and descends along the inner border of the triceps to the space between the internal condyle

Branches of Brachial Artery
1 Profunda Superior
2 " inferior
3 Anastomotica Magna
4 Muscular {Biceps, Coraco...}

and the olecranon, where it freely inosculates with the posterior ulnar recurrent artery.

The inferior profunda gives branches to the triceps and brachialis anticus muscles, some of which inosculate with the anastomotica magna.

The *medullary artery* of the humerus usually arises from the profunda inferior. It pierces the tendon of the coraco-brachialis, enters the nutritious foramen of the bone, and in the medullary canal divides into ascending and descending branches, which anastomose with the other nutrient vessels of the bone derived from the periosteum.

42. The *anastomotica magna artery* arises from the inner side of the brachial, about one or two inches above the elbow, runs tortuously inwards across the brachialis anticus muscle, and divides into branches, some of which pass in front of, and others behind the internal condyle, anastomosing with the inferior profunda and the anterior ulnar recurrent arteries.

Numerous unnamed *muscular branches* arise from the outer side of the brachial artery; one of these, more constant than the rest, supplies the biceps; another runs transversely beneath the coraco-brachialis and biceps, over the insertion of the deltoid, supplying this muscle and the brachialis anticus.

43. The two veins (*venæ comites*) which accompany the brachial artery are continuations of the deep radial and ulnar veins. The internal is usually the larger, since it generally receives the veins corresponding to the principal branches of the artery. In their course they are connected at intervals by transverse branches either in front of, or behind the artery. Near the subscapularis muscle the *vena comes externa* generally crosses obliquely over the front of the axillary artery to join the *v. c. interna*, which then takes the name of the axillary vein.

DISSECTION OF THE FRONT OF THE FORE-ARM.

44. Having prolonged the incision down to the wrist, reflect the skin from the front and sides of the fore-arm, and examine the subcutaneous nerves and veins.

On the radial side of the fore-arm will be found the superficial radial veins, with filaments of the external cutaneous nerve.

On the ulnar side are the superficial ulnar veins, accompanied by filaments of the internal cutaneous nerve.

The external cutaneous branch of the musculo-spiral nerve along the outer and back part of the fore-arm.

About the lower third of the radial border of the forearm, the radial nerve becomes superficial, and turns over the radius to supply the back of the hand and fingers.

Near the styloid process of the ulna, the superficial branch of the ulnar nerve perforates the fascia to reach the back of the hand.

45. The largest veins of the hand are placed on its dorsal surface, in order to be out of the way of pressure. Commencing at the extremity, and running on either side of the fingers, the veins unite on the back of the hand to form a plexus in the shape of an arch, with its concavity upwards, from which the veins of the fore-arm arise.

From the external side of the arch, near the metacarpal bone of the thumb, several branches unite to form the superficial *radial* veins, which run along the outer and front part of the fore-arm to the bend of the elbow, receiving numerous smaller veins in their course.

From the internal side of the arch, near the metacarpal bone of the little finger, commences the root of the superficial *ulnar* veins, which proceed along the inner and front side of the fore-arm to the elbow.

Along the middle of the fore-arm lies the median vein, which is formed by the superficial veins in front of the wrist, and terminates at the elbow by joining the cephalic and the basilic veins.

Such is the most frequent arrangement of the veins, but they are subject to great variety, and they always communicate by large branches with each other. For the disposition of the superficial veins at the elbow, see § 26.

46. Examine the *superficial nerves* of the fore-arm.

a. The *external cutaneous nerve* perforates the fascia between the outer edge of the tendon of the biceps and the supinator radii longus muscle. It passes sometimes above, but most frequently below, the median cephalic vein, sending generally a slender fila-

ment in front of it, and divides into two principal branches, which supply the integuments on the radial border of the fore-arm.

The filaments of this nerve may be traced, in company with the superficial radial veins, down to the wrist. It should be observed, that a branch of the nerve lies for some distance superficial to the radial artery in the lower third of the fore-arm : this branch perforates the fascia near the wrist, accompanies the artery beneath the extensor tendons of the thumb, and is finally distributed to the carpal joint.

Near the wrist, the external cutaneous generally communicates with the radial nerve, and sometimes it sends a filament into the palm of the hand and another over the ball of the thumb.

b. The *external cutaneous branch of the musculo-spiral nerve* divides into filaments, which run along the outer and back part of the fore-arm as low as the wrist, communicating with filaments of the external cutaneous nerve.

c. The *internal cutaneous nerve* divides near the bend of the elbow into an *anterior* and a *posterior* branch, both of which descend along the ulnar border of the fore-arm to the wrist, in company with the superficial ulnar veins. The *anterior* branch, the larger of the two, passes sometimes in front of, but more frequently behind the median basilic vein, and then gives off numerous cutaneous filaments as far as the wrist, some of which join with a cutaneous branch of the ulnar nerve. The *posterior* branch runs over the internal condyle of the humerus, towards the back of the fore-arm, as low as the wrist. This branch sometimes sends a recurrent filament between the internal condyle and the olecranon, to join with the lesser internal cutaneous.

47. Remove the subcutaneous tissue, in order to see the fascia which envelopes the muscles of the fore-arm. It is much stronger than that of the upper arm, more dense and compact on the posterior than on the anterior surface of the fore-arm, and its strength on both surfaces increases as it approaches the wrist, in order that the numerous tendons in this situation may be more effectually maintained in their proper position.

The fascia is attached to the two condyles of the humerus, and

is strengthened by aponeurotic fibres, from the tendons of the biceps on the inner, and the brachialis anticus on the outer side.

The aponeurotic expansion derived from the inner edge of the tendon of the biceps is exceedingly strong, and of a semilunar form. It passes obliquely downwards and inwards, bracing the muscles on the inner side of the arm, and interlacing at right angles with the fibres of the fascia attached to the internal condyle. The relation which it bears to the brachial artery has been alluded to, § 29.

Along the fore-arm the fascia is attached to the ridge on the posterior part of the ulna. At the back of the wrist it is firmly connected with the ridges on the lower end of the radius, and forms the posterior annular ligament. On the front of the wrist it is continued into the anterior annular ligament.

The under surface of the fascia gives origin to the muscular fibres in the upper part of the fore-arm, and sends off a number of septa, which separate the muscles and form so many distinct sheaths, of which the presence is indicated by whitish lines on the surface.

The fascia presents numerous foramina for the passage of vessels and nerves. Over the fossa, at the bend of the elbow, it is very thin and almost deficient, so as to admit of a free communication between the subcutaneous and deep cellular tissue of the fore-arm.

48. Make a vertical incision through the fascia, and remove it from the muscles, only as far as this can be done without injury to the muscular fibres which arise from its under surface.

The muscles of the fore-arm are arranged in two groups: the *pronators* and *flexors* attached to the internal condyle, the *supinators* and *extensors* to the external. They form two sides of a triangular space in front of the elbow, bounded by the pronator teres on the ulnar, and the supinator longus on the radial side. This space contains the brachial artery and its two veins, with the tendon of the biceps on its outer, and the median nerve on its inner side.

The nerve does not always lie close to the artery; it may be distant, as much as half an inch from it. Sometimes the nerve lies immediately superficial to the artery, and very rarely to its outer side. Deep in the groove between the brachialis anticus and

the extensor carpi radialis longior muscles, will be found a branch of the superior profunda artery, and the musculo-spiral nerve.

One or two absorbent glands are sometimes found in the triangular space at the elbow, close to the division of the brachial artery.

Examine the muscles which are attached in succession by a common tendon to the internal condyle of the humerus: namely, the pronator radii teres, the flexor carpi radialis, the palmaris longus, the flexor sublimis digitorum, and the flexor carpi ulnaris.

49. The *pronator radii teres* muscle forms the inner side of the triangular space at the elbow. It arises fleshy from the lower part of the internal intermuscular septum, from the anterior surface of the internal condyle, and from the septum between it and the flexor carpi radialis on its outer side. It has also another origin, partly fleshy and partly tendinous, from the coronoid process of the ulna on the inner side of the insertion of the brachialis anticus. To have a good view of this second attachment, it is necessary to reflect that portion of the muscle which comes from the condyle.

From these two origins, which are separated by the median nerve, the fleshy fibres proceed obliquely downwards and outwards, and terminate in a strong, flat, tendon, which is inserted into a rough surface on the outer and back part of the radius about its middle.

The tendon of insertion into the radius is about one inch and a half in breadth, and receives fleshy fibres on its lower surface, and sometimes on its upper, close to the bone. It is covered by the supinator longus and extensor carpi radialis longior. The *action* of this muscle is simply to pronate the fore-arm.

50. The *flexor carpi radialis* muscle arises by a thin tendon from the internal condyle, between the pronator teres and the flexor sublimis digitorum; also from the intermuscular septa and the fascia. The fleshy fibres terminate in a flat tendon, which commences about the middle of the fore-arm, and descends towards its radial side. The tendon disappears at the wrist beneath the anterior annular ligament, passes through a groove in the os trapezium, lined by a synovial membrane, and is inserted by a broad expansion into the base of the second metacarpal bone, and some-

times also into the third. The tendon lies deep in the palm, and will be seen with the dissection of that part. This muscle bends the hand, and also assists in pronating it. The outer border of its tendon is the guide to the radial artery in the lower half of the fore-arm.

51. The *palmaris longus* muscle is situated on the inner side of the flexor carpi radialis. It arises from the common tendon attached to the internal condyle, and from the intermuscular septa. This slender muscle, contained in a groove between the flexor carpi radialis and the flexor sublimis digitorum, terminates about the middle of the forearm in a flat tendon, which descends vertically down the middle of the forearm to the wrist, where it passes over the annular ligament, and is continued into the palmar fascia. This muscle is a tensor of the fascia in the palm, and may also assist in bending the hand.

The palmaris longus is sometimes absent. The situation of its muscular portion is subject to variety; sometimes occupying the middle, and sometimes the lower third of the fore-arm. The tendon is in some instances wholly inserted into the anterior annular ligament. A small *bursa* is in some cases found between the tendon and the ligament.

52. The *flexor sublimis digitorum perforatus,* situated partly beneath and on the inner side of the preceding, is a muscle of considerable size. It has two distinct origins. The longer and more internal origin takes place from the lower border of the internal condyle, from the internal lateral ligament of the elbow joint, from the inner side of the coronoid process of the ulna, and from the inter-muscular septa. The shorter origin, separated from the preceding by the median nerve, takes place by tendinous and fleshy fibres from an oblique ridge, which commences on the front surface of the radius near the tuberosity, and terminates near the middle of the outer border of the bone. This, which is called its *radial origin,* is partly concealed by the insertion of the pronator teres. A broad thick muscle is thus formed, which passes down the middle of the fore-arm, and divides into four distinct muscular slips: from these, four tendons arise, which pass beneath the annular liga-

ment into the palm, and so on to the fingers, where they split to allow the passage of the deep flexor tendons, and are inserted into the base of the second phalanges. Its action is, therefore, to bend the second joint of the fingers, and afterwards the first.

In some instances there are only three tendons at the wrist; in such cases the tendon of the ring-finger gives off in the palm that of the little finger.

The four tendons at the wrist are not all situated on the same plane. Those of the middle and ring-fingers lie immediately above those of the fore and little fingers.

All the tendons, excepting sometimes that of the ring-finger, receive fleshy fibres on their outer borders as low as the annular ligament.

53. The *flexor carpi ulnaris* muscle is situated on the inner side of the flexor sublimis digitorum. It arises from the lower part of the internal condyle, and from the inner edge of the olecranon, these two origins forming a kind of arch, under which the ulnar nerve passes. It is also attached to the upper two-thirds of the posterior edge of the ulna, through the medium of the aponeurosis of the fore-arm. To obtain a good view of this aponeurosis, the muscle must be separated from the flexor profundus digitorum, which lies beneath it.

The tendon makes its appearance on the radial side of the muscle, about the lower third of the fore-arm, and receives fleshy fibres on its ulnar side as low as the wrist. It is *inserted* into the os pisiforme, and thence by a strong tendon into the base of the fifth metacarpal bone and the os unciforme.

The tendon of the flexor carpi ulnaris is the guide to the ulnar artery, which lies close to its radial border, and is in some instances partially overlapped by it. As it passes over the annular ligament, the tendon gives off externally a fibrous expansion to protect the ulnar vessels. A small *bursa* is sometimes found beneath its tendon just before its insertion into the os pisiforme. The *action* of this muscle is to bend the hand and incline it to the ulnar side.

54. The *supinator radii longus* muscle is situated on the outer side of the fore-arm, and forms the external boundary of the triangular space at the bend of the elbow. It arises from the outer side of

the humerus, commencing a little below the insertion of the deltoid, and extending down two-thirds of the ridge leading to the outer condyle; also from the intermuscular septum, which separates it from the triceps. The muscular fibres descend, and terminate about the middle of the fore-arm in a flat tendon, which gradually becomes narrower, and is inserted into the base of the styloid process of the radius. The inner border of the muscle is a guide to the radial artery. It supinates the hand, and also acts as a flexor of the fore-arm.

The examination of the deeper-seated muscles should be postponed till we have traced the vessels and nerves of the fore-arm.

55. The brachial artery usually divides opposite the coronoid process of the ulna into the radial and ulnar arteries.

The *radial artery* passes down the radial side of the fore-arm to the wrist, where it turns over the external lateral ligament of the carpus, beneath the extensor tendons of the thumb, appears for a short distance upon the back of the hand, and sinks into the space between the first and second metacarpal bones to form the deep palmar arch. Thus, a line drawn from the middle of the bend of the elbow to the metacarpal bone of the thumb, would nearly indicate its course. In the upper third of the fore-arm, the artery is situated between the pronator teres on the inner, and the supinator longus muscle on the outer side; the fleshy border of the latter overlaps it in muscular subjects. In the lower two-thirds of the fore-arm the artery is more superficial, and is placed between the tendons of the supinator longus on the outer, and the flexor carpi radialis on the inner side. In its course, it lies successively on the following muscles and tendons: first, upon the tendon of the biceps; secondly, upon the supinator radii brevis, separated from it by more or less fat and cellular membrane; thirdly, upon the tendon of the pronator teres; fourthly, upon the radial origin of the flexor sublimis; fifthly, upon the flexor longus pollicis; and, lastly, upon the pronator quadratus, and the extremity of the radius. The artery is accompanied by two veins, which communicate at frequent intervals by transverse branches, and join the venæ comites of the brachial artery at the bend of the elbow.

In the middle third of its course the artery is accompanied by

the radial nerve, (a branch of the musculo-spiral) which lies to its outer side. Below this point, the nerve leaves the artery, and passes under the tendon of the supinator longus to the back of the hand: in some instances, however, the nerve sends a filament with the artery as low as the wrist.

Thus, in the situation where the pulse is usually felt, the radial nerve no longer accompanies the artery, but here the vessel is accompanied by a branch of the external cutaneous nerve, which runs superficial to it; some of its filaments perforate the fascia, twine round the artery, and accompany it to the back of the hand.

Near the wrist the artery is covered by a strong layer of fascia, and is placed about one-third of an inch from the outer edge of the tendon of the flexor carpi radialis.

56. The following are the branches of the radial artery in the forearm:—

The *radial recurrent* artery is given off just below the elbow; it makes a slight curve downwards, and then runs upwards and outwards in front of the external condyle of the humerus, between the extensor carpi radialis longior and the brachialis anticus muscles, and terminates in a direct anastomosis with the superior profunda, a branch of the brachial. The radial recurrent sends numerous branches, which ascend and descend to the muscles in the neighbourhood, and is one of the chief arteries which supply the elbow-joint, anastomosing freely with the other articular arteries.

Numerous unnamed *muscular* branches are given off by the radial in its course.

57. The *arteria superficialis volæ* generally arises from the radial, about half an inch, or more, above the lower end of the radius; it runs superficially over the anterior annular ligament of the carpus, above or perhaps through the origin of the muscles of the ball of the thumb, into the palm of the hand, where it inosculates with the superficial branch of the ulnar, thus completing the superficial palmar arch.

There is great variety in the size and origin of the superficialis volæ; sometimes it is very large, arises higher than usual, and runs to the wrist parallel with the radial; sometimes it is very small, terminating in the muscles of the thumb; or it may be absent.

Branches of Radial in forearm. 1 Radial Recurrent
2 Arteria superficialis

58. The *anterior* and *posterior carpal* arteries are small branches of the radial, which run beneath the tendons, and supply the synovial membrane and bones of the carpus, anastomosing with the branches of the interosseous arteries and carpal branches of the ulna. The remaining branches of the radial will be described with the palm.

59. The *radial nerve,* a branch of the musculo-spiral, is given off above the bend of the elbow, deep between the extensor carpi radialis longior and brachialis anticus muscles; it descends along the fore-arm, on the outer side of the radial artery, in close contact with the inner edge of the extensor carpi radialis longior, and covered by the supinator radii longus. In the upper third of the fore-arm the nerve is at some distance from the artery; in the middle third it approaches much nearer to it; but in the lower third, the nerve, leaving the artery, passes obliquely underneath the tendon of the supinator longus, perforates the fascia on the outer side of the fore-arm, and generally divides into two branches, an *external* and an *internal,* which supply the skin on the back of the hand, thumb, and two next fingers.

a. The *external* branch, the smaller of the two, passes along the outer border of the supinator longus, and extends to the radial side of the thumb; it sends a branch to the external cutaneous nerve and the palmar filament of the median.

b. The *internal* division of the nerve passes over the extensor tendons of the thumb to the back of the hand, where it gives off the dorsal digital nerves. One ramifies on the ulnar side of the thumb, the second on the radial side of the index finger, the third divides so as to supply the opposite sides of the index and middle fingers, and is connected on the back of the hand with a branch of the ulnar nerve.

60. Examine the *course and relations of the ulnar artery.*

This artery, larger than the radial, arises from the brachial at the middle of the elbow, runs obliquely downwards and inwards along the ulnar side of the fore-arm to the wrist, where it passes over the anterior annular ligament near the pisiform bone, and entering the palm, forms the superficial palmar arch, by inosculating with the superficialis volæ, or some other branch of the radial.

In the upper half of its course the artery inclines obliquely inwards, describing a gentle curve with the concavity towards the radius, and situated deep beneath the superficial layer of muscles—the pronator teres, flexor carpi radialis, palmaris longus, and flexor sublimis digitorum. In the lower part of its course it descends longitudinally between the flexor sublimis digitorum and flexor carpi ulnaris, and is only covered by the general aponeurosis of the forearm and a strong layer of fascia, which passes from the tendon of the flexor carpi ulnaris to the flexor profundus digitorum. At its commencement the ulnar artery rests for a short distance on the insertion of the brachialis anticus muscle; in the remainder of its course it lies on the flexor profundus digitorum.

The ulnar nerve, passing behind the internal condyle, is at first separated from the artery by a considerable interval: about the middle third of the forearm it joins the artery, and accompanies it in the rest of its course, lying close to its inner side. Both pass over the anterior annular ligament of the carpus, lying close to the pisiform bone,—the nerve being nearer to the bone, and the artery more superficial. A strong aponeurotic expansion from the tendon of the flexor carpi ulnaris protects them in this exposed situation.

As the artery lies on the brachialis anticus muscle it is crossed superficially by the median nerve,—the second head of the pronator teres intervening. In some instances this second head passes beneath the artery.

Observation should be particularly directed to the depth of the ulnar artery from the surface, and the many muscles which cover it in the upper third of its course. In the middle third of the fore-arm it is partially overlapped by the flexor carpi ulnaris. In the lower third it lies close to the radial border of the flexor carpi ulnaris, which is the proper guide to the vessel.

61. The following are the principal branches of the ulnar artery in the forearm:

The *anterior* and *posterior ulnar recurrent* arteries arise immediately below the elbow-joint,—sometimes by a common trunk, sometimes separately.

The *anterior*, the smaller of the two, passes upwards in front of

Branches of Ulnar in forearm
1 anterior ulnar recurrent
2 Posterior "
3 Common interosseous
4 Arteria comes nervi mediani
5 anterior carpal
6 Posterior "

the brachialis anticus, beneath the pronator teres, and inosculates with the inferior profunda and anastomotica magna arteries.

The *posterior* ulnar recurrent ascends beneath the flexor sublimis digitorum, to the space between the internal condyle and the olecranon, where it passes between the two heads of the flexor carpi ulnaris in company with the ulnar nerve. The artery lies close to the internal lateral ligament, through which many small branches pass, to supply the synovial membrane of the elbow-joint. This artery, like the former, supplies the surrounding muscles, and communicates freely with the anastomotica magna and inferior profunda, and the other articular arteries. Both the ulnar recurrent arteries send off descending branches, which supply the muscles on the inner side of the fore-arm.

The next branch of the ulnar is the *common interosseous* artery, which arises about an inch and a half below the division of the brachial, near the point where the ulnar artery is crossed by the second head of the pronator teres. The further examination of the interosseous artery must be for the present postponed. (See § 67.)

Numerous *muscular* branches arise from the ulnar artery in its course down the fore-arm.

A branch (*arteria comes nervi mediani*) almost always accompanies the median nerve. It lies in close contact with the nerve, and sometimes in its very centre: though usually of small size, it may be as large as the ulnar artery itself; and in such a case it passes under the annular ligament with the nerve, to join the arterial arch in the palm.

Immediately above the styloid process of the ulna, the ulnar artery sends off *anterior* and *posterior carpal* branches, similar in their course and distribution to the corresponding branches from the radial, with which they freely communicate, supplying the synovial membrane and bones of the carpus.

A little below the pisiform bone the ulnar artery divides into a deep and superficial palmar branch, which will be described with the anatomy of the palm of the hand.

62. The *ulnar nerve* descends behind the internal condyle between the two origins of the flexor carpi ulnaris. In its course down the upper part of the fore-arm, the nerve is still covered by

this muscle, and lies upon the flexor profundus digitorum. About the middle third of the fore-arm, the nerve joins the ulnar artery, and runs along its inner side over the annular ligament into the palm. In the lower part of the forearm, the nerve is not quite so superficial as the artery, being more or less overlapped by the tendon of the flexor carpi ulnaris.

Behind the internal condyle a slender filament from the ulnar nerve may sometimes be traced through the internal lateral ligament into the elbow-joint.

One or two branches enter the upper part of the flexor carpi ulnaris, and another, given off a little lower down, supplies the inner half of the flexor profundus digitorum; the outer half being supplied by the median nerve.

Near the middle of the fore-arm, a slender cutaneous branch sometimes comes from the ulnar nerve, and divides into two filaments, one of which perforates the fascia, and joins a filament of the internal cutaneous, the other accompanies the ulnar artery, and supplies the skin of the palm.

a. About one inch and a half above the styloid process of the ulna the nerve gives off a large cutaneous branch to the back of the hand. It crosses obliquely under the tendon of the flexor carpi ulnaris, and, immediately below the styloid process of the ulna, appears on the back of the hand, where it divides into two branches,—of which the one runs on the inner side of the little finger, the other subdivides, to supply the outer side of the little finger, both sides of the ring, and generally half the middle finger. This branch communicates with a filament from the dorsal branch of the radial nerve.

63. Examine the *median nerve.* It will be found in the triangular space at the bend of the elbow on the inner side of the brachial artery. It passes between the two origins of the pronator teres, and descends along the middle of the fore-arm, lying between the flexor sublimis and the flexor profundus digitorum: the nerve then enters the palm beneath the anterior annular ligament of the carpus, and terminates by dividing into five branches for the supply of the thumb, both sides of the fore and middle fingers, and the outer side of the ring finger.

In the upper three-fourths of the fore-arm the median nerve lies deep between the muscles; but in the lower fourth it is more superficial, and runs very nearly down the centre of the wrist. Its exact position is between the fleshy border of the outer tendon of the flexor sublimis and the inner border of the tendon of the flexor carpi radialis, from which in an arm of ordinary size the nerve is about a quarter of an inch distant.

If the tendon of the palmaris longus happen to be broader than usual, it may partially cover the median nerve near the wrist: but most frequently the nerve is immediately beneath the fascia,—the tendon lying to its ulnar side.

Immediately below the elbow, the median nerve sends off branches to supply the pronator and all the flexor muscles of the fore-arm, with the exception of the flexor carpi ulnaris and the inner half of the flexor profundus, which are supplied by the ulnar nerve. The branch to the pronator teres and the radial flexor is sometimes given off above the elbow, and one of these muscular nerves sometimes sends a filament which penetrates the front of the elbow joint. The interosseous branch of the median will be described with the corresponding artery. (See § 68.)

Before the median nerve passes beneath the annular ligament of the wrist it sends off its superficial palmar branch. This branch lies close to the radial side of the median nerve, perforates the fascia at the wrist, and, passing over the anterior annular ligament, divides into small filaments, which communicate with a corresponding branch from the radial nerve, and supply the skin of the palm and ball of the thumb.

Divide the superficial layer of muscles across the centre of the forearm, and reflect them, in order to obtain a full view of those more deeply seated. Observe the intervening fascia. The principal vessels and nerves should be preserved.

The deep-seated muscles consist of the flexor digitorum profundus, and the flexor longus pollicis; beneath both, in the lower fourth of the fore-arm, lies the pronator quadratus. On the interosseous membrane will be seen the anterior interosseous artery and nerve.

64. The *flexor profundus digitorum* is the largest and thickest

muscle of the forearm. It arises from the upper two-thirds of the anterior surface of the ulna, and from the same extent of its internal surface up to the olecranon, so that its origin embraces the insertion of the brachialis anticus; it arises also from the aponeurosis which is attached to the posterior edge of the ulna, from the inner two-thirds of the interosseous ligament, and sometimes by a few fibres from the inner edge of the radius.

The muscle, covered on its inner side by the aponeurosis connected with the flexor carpi ulnaris, divides about the middle of the fore-arm into three or four muscular slips, which terminate in as many broad, flat, tendons. These tendons lie upon the same plane, and pass beneath the annular ligament under those of the superficial flexor, into the palm. On the first phalanx of the fingers, the tendons of the deep flexor perforate those of the superficial, and are inserted into the base of the third or ungual phalanx of the fingers.

The tendons receive muscular fibres on their under surface quite down to the wrist. Those of the ring and little fingers are generally connected with each other, but that of the index finger is almost always distinct from the rest, and therefore capable of independent action.

The flexor profundus bends the last joint of the fingers.

65. The *flexor longus pollicis* is situated on the front surface of the radius, on the same plane with the last muscle. It arises by delicate fleshy fibres from the front surface of the radius, comprising the space between the tubercle and the pronator quadratus, also from the interosseous membrane, and often by a slip from the coronoid process of the ulna. Its flat tendon makes its appearance high up in the muscle, receives fleshy fibres on its under and outer surface as low as the wrist, and proceeds beneath the annular ligament to the last phalanx of the thumb.

66. The square muscle at the lower end of the radius and ulna is called the *pronator quadratus,* and may be exposed by separating the tendons of the muscles last described, which pass over it; it arises from the internal border and the anterior surface of the lower fourth of the ulna; its fibres pass nearly transversely outwards, and are inserted into the anterior surface of the lower fourth of the ra-

dius; the muscle is thicker than it appears, and its superficial fibres are much longer than those which pass between the mesial border of the bones. It rotates the radius on the ulna.

67. Nearly on a level with the insertion of the biceps, the ulnar artery gives off from its outer side the *common interosseous* trunk, a large branch, about half an inch or more in length, which passes backwards and divides into two,—the *anterior*, and *posterior interosseous* arteries.

The *anterior interosseous* artery descends along the interosseous membrane, nearer to the radius than the ulna, lying between the flexor profundus digitorum and the flexor longus pollicis. At the upper edge of the pronator quadratus it divides into two branches; one of which, the smaller of the two, supplies the muscle and descends in front of the carpal bones, communicating with the anterior carpal arteries from the radial and ulnar, and the deep palmar arch; the other perforates the interosseous membrane, and divides into branches which inosculate with the posterior carpal and posterior interosseous arteries.

The anterior interosseous artery gives off branches to the muscles on either side, and the nutritious arteries which perforate the anterior surface of the radius and ulna from below upwards, near the centre of the forearm, to supply the medullary membrane. Several small branches pierce the interosseous membrane, and are distributed to the muscles on the back of the forearm.

68. The anterior interosseous nerve is a branch of the median; it lies close to the outer side of the artery, sends filaments to the flexor longus pollicis and flexor profundus digitorum, and is lost in the under surface of the pronator quadratus.

The interosseous artery is sometimes confined to the interosseous membrane by a layer of fibrous tissue; hence the occasional difficulty in placing a ligature round it after amputation.

DISSECTION OF THE PALM OF THE HAND.

69. A longitudinal incision should be made through the skin down the centre of the palm to the cleft between the middle and ring fingers:

in reflecting the skin, observe the peculiar structure of the subcutaneous tissue.

Over the ball of the little finger and the distal ends of the metacarpal bones, the subcutaneous structure is composed of a very dense filamentous cellular tissue, which contains numerous pellets of fat, forming a kind of elastic cushion. This structure is prolonged down the fingers to their extremities: it is less developed over the ball of the thumb and in the palm of the hand, where the skin is closely connected to the subjacent palmar fascia.

Numerous openings will be observed in the fascia for the transmission of cutaneous vessels and nerves, which come from the superficial palmar arch.

Be careful not to remove a small cutaneous muscle, the palmaris brevis, which is situated at the upper and inner part of the palm.

70. In the dense cellular tissue over the anterior annular ligament of the carpus, will be found the *superficial palmar branch of the median nerve;* it is derived from the median above the annular ligament, over which it passes into the palm of the hand, and subdivides into numerous cutaneous filaments: it is often joined by small branches from the radial and external cutaneous nerves.

71. Examine the *palmar fascia.* This membrane has a silvery lustre, and, in the centre of the palm, is remarkably dense and strong; it is divided into three portions, a central,—by far the most conspicuous; an external, covering the muscles of the thumb; and an internal, covering the muscles of the little finger. From the deep surface of the fascia two fibrous septa dip down, so as to divide the palm into three separate compartments; one for the ball of the thumb, a second for that of the little finger, and a third for the centre of the palm.

The fascia is formed in great part by an expansion of the tendon of the palmaris longus, but is also materially strengthened by fibres from the anterior annular ligament. In cases, therefore, where the palmaris longus is absent, the palmar fascia is not necessarily deficient.

The central portion of the fascia is triangular in form with the

apex at the wrist. About the middle of the palm it splits into four portions, which are connected together by strong transverse tendinous fibres, extending completely across the palm, and corresponding pretty nearly to the transverse furrow of the skin in this situation.

Each of these four divisions of the fascia splits into two portions, which embrace the corresponding flexor tendons, and are intimately connected with the fibro-cartilaginous ligament of the first joint of the fingers. In this way, the flexor tendons of each finger are surrounded and kept in place in the lower part of the palm, by a kind of fibrous ring formed by the palmar fascia. In order to see this distinctly, the fascia should be divided longitudinally over one of the tendons. The manner in which it embraces the tendons, as well as its deep connexion with the transverse metacarpal ligament of the fingers, will be readily recognized. Between the four primary divisions of the palmar fascia the digital vessels and nerves will be observed, surrounded by fibro-cellular tissue and fat, and descending nearly in a line with the clefts between the fingers.

In the hands of mechanics, in whom the palmar fascia is usually very strong, we commonly find that slips of it are lost in the skin at the lower part of the palm, and also for a short distance along the sides of the fingers.

The chief use of the palmar fascia is to protect the vessels and nerves from pressure when anything is grasped in the hand. It also confines, and binds down the flexor tendons of the fingers in their proper place.

Between the interdigital folds of the skin, are found aponeurotic fibres, constituting what are called the *transverse ligaments of the fingers*. They are connected with the palmar fascia, and with the heads of the first phalanges, and form a continuous ligament across the lower part of the palm, in front of the digital vessels and nerves. Their office is to prevent a too great separation of the fingers.

The *external* and *internal* portions of the palmar fascia, covering respectively the muscles of the ball of the thumb and the little finger, are both continuous with the central portion.

The external portion is connected with the anterior annular ligament, and receives an expansion from the tendon of the extensor ossis metacarpi pollicis. It passes over the muscles forming the ball of the thumb, and is attached to the radial border of the first metacarpal bone. The internal portion, thin and transparent, is chiefly derived from the tendon of the flexor carpi ulnaris ; it covers the muscles of the little finger, and is inserted into the ulnar border of the fifth metacarpal bone.

72. The *palmaris brevis* is a small cutaneous muscle, situated at the upper and inner side of the palm. It consists of several small bundles of muscular fibres, separated by fat and cellular tissue, which arise from the inner edge of the central portion of the palmar fascia, pass transversely inwards, and terminate in the skin on the inner side of the palm. Its use is to increase the concavity of the palm, by drawing the skin towards the centre of the hand.

Divide the tendon of the palmaris longus, and reflect the palmar fascia from the annular ligament towards the fingers ; observe the attachment of its deeper fibres to the lower border of the ligament. Remove the loose cellular tissue which permits the free play of the tendons beneath the fascia, and expose with care the vessels and nerves in the palm.

73. *Superficial palmar arterial arch.*—The ulnar artery passes over the annular ligament of the wrist near the pisiform bone, describes a curve across the upper part of the palm beneath the palmar fascia, and, gradually diminishing in size, inosculates with the superficialis volæ, or some other branch of the radial, so as to form the superficial palmar arch. The curve of the arch is directed towards the ball of the thumb, and crosses over the flexor tendons and the divisions of the median nerve. No precise rule can be given for finding its exact position in the hand : most commonly its greatest convexity descends as low as a horizontal line drawn across the junction of the upper with the middle third of the palm ; but sometimes it descends as low as the centre of the palm.

In its passage over the annular ligament, the artery is protected by the projecting pisiform bone, and by a tendinous expansion which passes from the tendon of the flexor carpi ulnaris to that of the palmaris longus. The ulnar nerve lies close to its inner side,

In the palm, the artery lies for a short distance upon the muscles of the little finger, before it crosses the flexor tendons, and it is covered by the palmaris brevis muscle and the palmar fascia.

74. *Branches of the ulnar artery in the palm.*—Immediately below the pisiform bone, the ulnar artery gives off the *ulnaris profunda,* which sinks deep into the palm between the abductor and flexor brevis minimi digiti, to assist in forming the deep palmar arch (see § 98). It is accompanied by a large branch of the ulnar nerve.

From the concavity of the superficial palmar arch small branches ascend to the carpus, and there inosculate with the other carpal branches of the radial and ulnar arteries.

From the convexity of the arch there commonly arise *four digital arteries,* which supply all the fingers, excepting the radial side of the index finger. The first descends obliquely over the muscles on the inner side of the palm, to the ulnar side of the little finger, along which it runs to the apex. The second, third, and fourth descend nearly vertically between the tendons, in a line with the clefts between the fingers, and about half an inch above the clefts each divides into two branches, which proceed along the opposite sides of the palmar aspect of the fingers nearly as far as the extremity of the last phalanges, where they unite to form an arch with the convexity towards the end of the finger; from this arch numerous branches arise and supply the papillæ of the skin, endowed with the exquisite sense of touch.

In the palm of the hand the digital arteries send small branches to the lumbricales muscles and the sheaths of the flexor tendons, and each is generally joined by a small branch from the corresponding palmar interosseous artery, a branch of the deep palmar arch (see § 98).

The arteries freely communicate, both on the palmar and dorsal aspect of the fingers, by transverse branches, which supply the oints and the sheaths of the tendons. Near the ungual phalanx, a considerable branch passes to the back of the finger, and forms a network of vessels round the root of the nail.

The arteries in the palm are accompanied by small veins, which surround them by their frequent communications.

…ches of Ulnar in palm. { 1 Ulnaris profunda
2.4 Digital arteries

75. The *ulnar nerve* passes over the annular ligament into the palm, on the inner side of, and rather behind the ulnar artery. It is protected by a process of fascia, and lies in a groove between the pisiform and unciform bones, so that it is perfectly secure from pressure in this apparently exposed situation. A small *bursa* is sometimes found between the nerve and the ligament.

Immediately below the pisiform bone, the ulnar nerve divides into a superficial and a deep palmar branch. The deep branch supplies the muscles of the little finger, and accompanies the ulnaris profunda artery into the palm (see § 99).

The superficial branch divides into two digital nerves, for the supply of both sides of the little finger and the ulnar side of the ring finger. The more internal of these two nerves sends filaments to the palmaris brevis, to the integument on the inner side of the palm, and is joined by a filament from the dorsal cutaneous branch of the ulnar nerve; it then runs along the ulnar side of the palm, internal to its corresponding artery, and is continued along the inner side of the little finger to the extremity. The other nerve descends internal to its corresponding artery, and passes obliquely over the flexor tendons of the little finger towards the cleft between the little and ring fingers, where it subdivides into two branches, which run along the opposite sides of these two fingers to their extremities. It also sends a filament to communicate with the median nerve, behind the superficial palmar arch.

76. *Anterior annular ligament of the carpus.*—This exceedingly strong and thick ligament confines the flexor tendons of the fingers and thumb, and fastens together the bones of the carpus. It is attached externally to the scaphoid and trapezium bones; internally to the pisiform and unciform, and to the ligament connecting them. It is made up of oblique and transverse fibres, interlacing more or less with each other. Its upper border is continuous with the aponeurosis in front of the wrist; its lower border terminates in the palmar fascia; its anterior surface receives the expanded tendon of the palmaris longus, and gives origin to most of the muscles constituting the ball of the thumb and little finger.

Cut vertically through the ligament, and observe, that, with the concavity of the carpal bones, it forms a complete elliptical canal,

with the broad diameter transversely, and somewhat expanded at either end. Its internal surface is lined by a synovial membrane which is reflected loosely over the tendons. The canal transmits the superficial and deep flexor tendons of the fingers, the long flexor tendon of the thumb, and the median nerve. The tendon of the flexor carpi radialis is contained in a distinct sheath, lined by synovial membrane, formed partly by the annular ligament and partly by the groove in the trapezium.

77. *Branches of the median nerve in the palm.*—In its passage under the annular ligament, the median nerve is enveloped in a fold of synovial membrane; it becomes considerably wider and flatter, and might be mistaken for one of the tendons. It lies between the tendons of the flexor digitorum sublimis and the flexor longus pollicis, and upon those of the flexor profundus; and it is rather nearer to the radial than the ulnar side of the wrist. As soon as it appears in the palm, the nerve lies superficial to all the tendons, gives a branch to the muscles of the ball of the thumb, and then divides into five branches, two for the thumb, the rest for the fore and middle fingers and the radial side of the ring finger: these three last are crossed by the superficial arterial arch.

The muscular branch is given off immediately below the annular ligament, curves upwards, and divides into filaments which supply the muscles of the ball of the thumb.

The two nerves of the thumb proceed, one on each side of the long flexor tendon, to the last phalanx.

The first digital nerve passes down the outer edge of the first lumbricalis muscle, and runs along the radial side of the index finger.

The second digital nerve crosses the tendon of the index finger, descends vertically towards the cleft between the index and middle fingers, and subdivides into two branches, which supply their opposite sides.

The third crosses obliquely over the tendon of the middle finger, is joined by a filament from one of the ulnar digital nerves, and then subdivides above the cleft between the middle and ring fingers, to supply their opposite sides.

In the palm of the hand, the digital nerves are situated on a

plane beneath the arteries, but most of them communicate with each other by slender filaments which cross in front of the vessels. They send small filaments to supply the first, second, and sometimes the third lumbricalis muscle, and others which pass through the fascia to the skin of the palm.

About an inch and a quarter above the clefts between the fingers, each digital nerve subdivides into two branches, between which the digital artery passes and bifurcates rather lower down; therefore a vertical incision down the cleft would divide the artery before the nerve.

78. In their course along the fingers and thumb, the nerves lie superficial to the arteries, and rather nearer to the flexor tendons. Near the middle of the first phalanx each nerve sends a considerable branch, which runs along the back of the finger nearly to the extremity, communicating with the dorsal branches derived from the radial and ulnar nerves. Near the ungual phalanx another branch is distributed to the skin around and beneath the root of the nail. Small branches of the digital nerves encircle the trunks of the digital arteries, giving filaments to the skin of the finger and the external surface of the sheaths of the tendons; other filaments, accompanied by small arteries, enter the tendons themselves through the slender synovial bands attached to their posterior surface. Each nerve terminates near the end of the finger in a brush of filaments, accompanied by minute arteries, with their points directed to the papillæ of the skin. A communication may sometimes be traced between the two nerves.

79. *Corpuscles of Pacini.*—These are little semitransparent elliptical bodies, which are observed chiefly upon the cutaneous nerves of the hands and feet. Some of them will be readily found by carefully examining the trunk of a nerve, or one of its smaller branches, in the subcutaneous tissue at the root of a finger. Each corpuscle is attached by a slender fibro-cellular pedicle to the nerve upon which it is situated; through the pedicle a single primitive nerve-fibril passes into the corpuscle. The corpuscle itself is composed of a series of concentric capsules, separated by intervals containing fluid; and the nerve-fibril terminates in a central cavity which exists in the axis of the corpuscle.

80. *Flexor tendons and their sheaths.*—Observe the arrangement of the flexor tendons beneath the annular ligament, and trace them to the ends of the fingers. The tendons of the flexor sublimis are arranged in two layers, the one above the other. Those of the flexor profundus lie on the same plane, and are sometimes connected by thin tendinous slips; but the tendon of the index finger is always distinct. Immediately below the annular ligament the tendons separate from each other; those of the superficial flexors are placed in front of the deep flexors, and near the metacarpal joints of the fingers they pass in pairs through strong fibrous sheaths, resulting from the divisions of the palmar fascia (see § 71). Below the metacarpal joint the two tendons for each finger enter the sheath which confines them in their course along the phalanges. It is formed by a strong fibrous membrane, which is attached to the projecting ridges on either side of the first and second phalanges, and thus converts the groove in front of these bones into a complete canal, exactly large enough to contain the tendons. The density of the sheath necessarily varies in particular situations, otherwise there would be an obstacle to the easy flexion of the fingers. To ascertain this, let one of the sheaths be opened along its entire extent; it will then be obvious that it is much stronger over the phalanges, that is, between the joints, than over the joints themselves, where it is always very thin, and is sometimes deficient; through these sheaths, inflammation commencing in the integuments of the finger may readily extend to the synovial membrane of the tendon.

On closer inspection it will be observed that the sheath is composed of bands of fibres, which take different directions, and have therefore received distinct names. The strongest of these are called the *ligamenta vaginalia.* They constitute that part of the sheath which corresponds to the body of the phalanx, and extend transversely from one side of the bone to the other; they are much stronger over the first than the second phalanges. The *ligamenta cruciata* are two cross tendinous slips, situated at the lower part of the first and the second phalanges. They are attached to either side of the upper end of the phalanges, and cross obliquely over the tendons to the opposite border of the body of the bone; one

or other of them is often deficient. The *ligamenta annularia* are situated immediately in front of the joints, and may be considered as thin continuations of the ligamenta vaginalia. They consist of delicate fibres, which are attached on either side of the joints to the glenoid ligaments, and pass transversely over the tendons. They are often indistinct.

Open one of the sheaths, and it will be seen that in front of the articulations the tendons glide over a smooth fibro-cartilaginous structure, called the *glenoid* ligament. In some cases, as, for instance, at the last joint of the thumb, this ligament contains a small sesamoid bone.

81. The interior of the sheath, as well as the surface of the tendons, is lined by a delicate synovial membrane, of the extent of which it is important to have a correct knowledge. With a probe, or other blunt instrument, we may easily ascertain that the synovial membrane is reflected from the sheath upon the tendons, a little above the metacarpal joints of the fingers; that is, nearly in a line with the transverse fold in the skin observed in the lower third of the palm. Towards the distal end of the finger, the synovial sheath commonly stops short of the last joint, so that it is not injured in amputation of the ungual phalanx.

82. With regard to the tendons themselves, we observe that the superficial flexor, near the root of the finger, presents on its under surface a slight groove which receives the corresponding deep flexor tendon; about the middle of the first phalanx it splits into two portions, through which the deep flexor passes. The two portions reunite below the deep tendon so as completely to embrace it, and then divide a second time into two slips, which interlace with each other and are inserted into the outer and inner sides of the second phalanx. In some instances, the superficial flexor tendon has an attachment to the sides of the first phalanx, so that, if the finger were amputated at the second joint, the power of bending the first might, to a certain extent, be retained.

The deep flexor tendon, having passed through the opening of the superficial flexor, is attached to the whole breadth of the base of the last phalanx.

By raising the tendons from the sheath, and separating them

from each other, we shall observe what are called the *vincula tendinum.* They consist of folds or bridles of the synovial membrane, which convey minute blood-vessels and nerves to the tendons. They are generally triangular, with their bases attached longitudinally along the middle of the phalanx. The fold from the first phalanx, after supplying the superficial flexor tendon, passes through the bifurcation to the deep flexor. Sometimes additional vincula tendinum proceed to the tendons from the sides of the phalanges.

83. The *tendon of the flexor longus pollicis* lies on the radial side of the other flexor tendons beneath the annular ligament. It passes outwards between the two portions of the flexor brevis pollicis and the two sesamoid bones of the thumb, enters its proper fibrous sheath, and is inserted by a broad expansion into the base of the last phalanx.

The tendon is provided with a synovial sheath, which is prolonged from the large bursa of the flexor tendons beneath the annular ligament, and accompanies it down to the last joint of the thumb; consequently the sheath is injured in amputation of the ast phalanx.

84. A large and loose synovial sac, called the *bursa of the carpus,* is placed b eneath the anterior annular ligament of the wrist, for the purpose of facilitating the play of the tendons through the carpal groove. It lines the under surface of the ligament and the groove formed by the carpal bones, and is thence reflected in loose folds over the tendons, separating them more or less from each other. Above the upper edge of the ligament it is prolonged over both surfaces of the tendons to the extent of an inch, or sometimes two inches, and the cul-de-sac thus formed reaches higher on their deep than on their superficial surface. Below the ligament the bursa extends for a short distance into the palm, and sends off prolongations for each of the flexor tendons, which accompany them nearly down to the middle of the hand. Thus it will be easily understood, that, when the bursa is distended by fluid, there will be a bulging above the annular ligament, and another in the palm, with perceptible fluctuation between them; the unyielding ligament causing a kind of constriction in the centre.

In some very rare instances the bursa communicates with the

wrist joint. It communicates always with the synovial sheath of the long flexor tendon of the thumb, in most cases with that of the flexor tendons of the little finger, and but rarely with that of the index, middle and ring fingers. On this account, inflammation of the theca of the thumb or little finger, is more liable to be attended with serious consequences than either of the others.

85. The *lumbricales,* four slender muscles, one for each finger, are attached to the tendons of the flexor profundus in the palm. They are distinguished as first, second, third, and fourth, counting from the index finger, and all of them arise from the radial side of the deep flexor tendon of their corresponding finger: the third and fourth generally arise from the adjacent sides of two tendons. Each little muscle terminates in a broad thin tendon which passes over the radial side of the first joint of the finger, and is inserted into the expansion of the extensor tendon on the back of the finger. Their *action* is not satisfactorily determined; they may probably be of use in bending the first joint of the fingers. The number of these muscles is not always constant; it may be increased by one, in which case one finger, usually the ring, has two muscles, one on either side; or it may be diminished by one; sometimes one of them divides, so as to send a tendon to the opposite sides of two fingers.

86. *Muscles constituting the ball of the thumb.*—The most superficial of these is a broad flat muscle, the *abductor pollicis.* It arises from the os scaphoides, from the superficial fibres of the anterior annular ligament, and from an expansion derived from the tendon of the extensor ossis metacarpi pollicis. It is inserted by a flat tendon into the base of the radial side of the first phalanx of the thumb. A small *bursa* is sometimes found beneath its tendon. Its *action* is to draw the thumb forwards and inwards away from the index finger.

87. Reflect the abductor pollicis from its insertion. A strong and thick muscle lies beneath it, called the *flexor ossis metacarpi,* or *opponens pollicis.* It arises from the os trapezium and the anterior annular ligament, and is inserted by fleshy fibres into the whole length of the radial side of the metacarpal bone of the

thumb. The *action* of this muscle is to oppose the thumb to the fingers.

88. Reflect the flexor ossis metacarpi from its insertion, and be careful not to remove with it a muscle situated beneath it, and to its inner side, called the *flexor brevis pollicis.* This muscle has two distinct origins; one from the lower edge of the annular ligament and the os trapezium, the other from the os trapezoides, os magnum, and the upper end of the third metacarpal bone. The two portions of the muscle unite behind the tendon of the flexor longus pollicis, and again separate near the lower end of the metacarpal bone of the thumb into an external and internal part, the latter being the larger. The external division, closely connected with the opponens pollicis, ends in a tendon which is inserted into the radial side of the base of the first phalanx of the thumb; the internal division, intimately united to a muscle in the palm called the adductor pollicis, is inserted by a tendon into the ulnar side of the base of the first phalanx of the thumb. A large sesamoid bone is found in each of the tendons. The lower portions of the muscle are separated by the long flexor tendon of the thumb and the arteria magna pollicis. Its *action* is to bend the first phalanx of the thumb.

Cut through the flexor tendons and the median nerve about three inches above the annular ligament of the wrist, and turn them out of the carpal groove and from the palm. A good view is thus obtained of the synovial bursa of the carpus. Observe the extent of the bursa above and below the ligament, and the loose manner in which it is reflected over the bundle of tendons (see § 84.) Observe also the loose and abundant cellular tissue which lies under the tendons in the palm, allowing them to play freely over the deep palmar fascia.

89. The *deep palmar fascia* covers the interosseous muscles and the deep palmar arch of arteries. It is comparatively thin towards the carpus, but very strong lower down, where it is connected with the transverse ligament uniting the heads of the metacarpal bones. On either side it is connected with the central portion of the superficial palmar fascia, so as to form a large com-

partment in the palm, containing the flexor tendons and the principal vessels and nerves. Thus, when suppuration takes place in the loose cellular tissue surrounding the tendons, we can easily understand why it is so long prevented from reaching the surface, either in the palm, or on the back of the hand (see § 71.)

90. We have yet to examine in the palm a triangular muscle belonging to the thumb, called the *adductor pollicis.* It arises from the lower two-thirds of the shaft of the metacarpal bone of the middle finger; its fibres converge outwardly, and are inserted, along with the inner portion of the flexor brevis pollicis, into the ulnar side of the base of the first phalanx of the thumb. Its *action* is to draw the thumb towards the palm.

91. *Muscles constituting the ball of the little finger.*—The muscles of the little finger correspond in some measure with those of the thumb. Thus we have an abductor, a flexor brevis, and an opponens minimi digiti. They are covered by a thin layer of the palmar fascia, which must be removed.

92. The *abductor minimi digiti,* the most internal and superficial of the muscles of the little finger, arises from the pisiform bone and from the tendon of the ~~extensor~~ carpi ulnaris. It passes along the border of the palm, and is inserted by a flat tendon into the inner side of the base of the first phalanx of the little finger. Its *action* is to draw this finger from the rest.

93. The *flexor brevis minimi digiti* is a long slender muscle, situated along the radial side of the abductor, of which it might fairly be considered as a portion. It arises from the unciform bone and the annular ligament, and is inserted with the tendon of the abductor into the ulnar side of the base of the first phalanx of the little finger. Its *action* is similar to that of the abductor.

Between the origins of the abductor and flexor brevis minimi digiti, the deep branch of the ulnar artery, accompanied by its nerve, sinks down to assist in forming the deep palmar arch.

94. The two last muscles must be reflected from their insertion, in order to expose the muscle beneath them, called the *adductor,* or *opponens digiti minimi.* It arises from the unciform bone and the anterior annular ligament. The fibres increase in length and obliquity from above downwards, and are inserted along the ulnar

side of the shaft of the metacarpal bone of the little finger. Its *action* is to draw this bone, which is the most moveable of all the metacarpal bones of the fingers, towards the thumb. Thus it materially assists in forming a hollow in the palm.

Remove the deep palmar fascia, and clean the deep arch of arteries which lies, surrounded by more or less fat, over the upper ends of the metacarpal bones. Trace the branches of the radial artery in the palm.

95. *Branches of the radial artery in the palm.*—The radial artery, after passing over the external lateral ligament of the carpus, and beneath the extensor tendons of the thumb, towards the back of the hand, sinks into the angle between the metacarpal bones of the thumb and fore finger, and generally gives off three principal branches—the arteria magna pollicis, the radialis indicis, and the palmaris profunda; but the arrangement of all the arteries in the palm is subject to frequent varieties.

96. The *arteria magna pollicis* runs in front of the abductor indicis muscle (first dorsal interosseous), close along the ulnar border of the metacarpal bone of the thumb: in the interval between the lower portions of the flexor brevis pollicis, the artery divides, beneath the long flexor tendon, into two branches, which proceed, one on either side of the thumb, and inosculate at the apex of the last phalanx. Their distribution and mode of termination are similar to those of the other digital arteries.

97. The *arteria radialis indicis* descends along the radial side of the second metacarpal bone, between the abductor indicis and adductor pollicis muscles, at the lower border of which it becomes superficial, and continues its course along the radial side of the index finger to the extremity, where it forms an arch with the other digital artery. Near the lower margin of the adductor pollicis, the radialis indicis generally receives a branch from the superficial palmar arch.

98. The *palmaris profunda* is sometimes considered as the continuation of the radial artery. It enters the palm between the inner origin of the flexor brevis and the adductor pollicis muscles, describes a curve, with the concavity towards the wrist, across the upper ends of the second, third, and fourth metacarpal bones, and inosculates

anches of Radial in palm. 1 Arteria magna pollicis
2 " radialis indicis
3 Palmaris profunda
4 Perforating branches

with the deep branch of the ulnar artery, which thus completes the deep palmar arch. From the curve of the arch small branches ascend to supply the bones and joints of the carpus, inosculating with the other carpal arteries. From the convexity of the arch three or four small branches, called *palmar interosseous,* descend to supply the interosseous muscles, and near the clefts of the fingers communicate with the digital arteries. These palmar interosseous branches are sometimes of considerable size, and take the place of one or more of the digital arteries, ordinarily derived from the superficial palmar arch.

a. Other branches, called the *perforating arteries,* are derived from the deep palmar arch. They pass between the upper ends of the metacarpal bones to the back of the hand, and there communicate with the carpal branches of the radial and ulnar arteries.

99. The *deep palmar branch of the ulnar nerve* sinks into the palm with the ulnaris profunda artery, between the abductor and flexor brevis minimi digiti muscles. It then crosses obliquely over the deep palmar arch towards the radial side of the palm, and disappears beneath the adductor pollicis.

Between the pisiform and unciform bones, the nerve gives a branch to each of the muscles of the little finger. Subsequently, filaments are sent to each interosseous muscle, and generally to the two internal lumbricales. Small filaments also accompany the perforating arteries to the back of the hand, and join the dorsal cutaneous branches of the ulnar and radial nerves. But the largest branches supply the adductor pollicis and abductor indicis muscles, and in some cases also the flexor brevis pollicis.

The dissection of the remaining muscles of the palm, called, from their position, *interossei,* must be for the present postponed (see § 150.)

DISSECTION OF THE MUSCLES OF THE BACK CONNECTED WITH THE ARM.

100. Make an incision through the skin over the spine from the occiput to the sacrum; another from the last dorsal vertebra,

upwards and outwards to the spine of the scapula, and thence along its spine to the acromion; and a third from the middle of the sacrum upwards and outwards for a short distance over the crest of the ilium. Reflect the skin from the dense subjacent superficial fascia.

101. The *cutaneous nerves of the back* are derived from the posterior branches of the spinal nerves; these branches, after supplying the muscles contained in the vertebral groove, pass through them and become subcutaneous in nearly a regular series, on either side of the spine, but not all at an equal distance from it. Thus in the cervical and upper dorsal region, the cutaneous nerves perforate the trapezius close to the spine: in the lower dorsal and the lumbar region, they perforate the latissimus dorsi in a line nearly corresponding to the angles of the ribs. Each cutaneous nerve then divides into internal and external branches, which supply the integument of the respective regions of the back to which they belong. Most of them are accompanied by small arteries. As might be expected, the external branches are by far the larger, especially in the loins, where some of them descend over the crest of the ilium, and terminate in the skin of the buttock.

Of these cutaneous nerves we need notice only the following:—

102. The *posterior branch of the second cervical nerve* is called from its distribution the *great occipital.* It perforates the complexus, ascends over the occiput, and ramifies upon the under surface of the scalp, in company with the branches of the occipital artery.

The *cutaneous branch of the third cervical nerve* also sends a branch of considerable size to the back of the scalp.

The *cutaneous branch of the second dorsal nerve* is generally the largest of all the dorsal cutaneous nerves. It may be traced outwards towards the spine of the scapula.

The *posterior branch of the second lumbar nerve* perforates the fascia lumborum near the posterior superior spine of the ilium, and descends over the crest of the ilium to supply the skin over the glutæal region.

Clean the superficial layer of the muscles of the back. Those with which we are now more immediately concerned are, the trapezius and the latissimus dorsi.

103. The *trapezius* is a broad flat muscle situated immediately beneath the skin of the cervical and upper part of the dorsal region. Taken alone it is triangular, but with its fellow of the opposite side it presents a trapezoid form. It arises by aponeurotic fibres from the spine of the occiput, and from the inner fourth, more or less, of its superior curved line; from the ligamentum nuchæ, and from the spinous processes of the seventh cervical, and all the dorsal vertebræ, as well as the interspinous ligaments. The fibres converge towards the shoulder. The upper are inserted fleshy into the external third of the clavicle; the middle, into the upper border of the acromion process and spine of the scapula; the lower terminate in a broad thin tendon, which plays over the triangular surface at the back of the scapula, and is inserted into the beginning of the spine. A *bursa* is frequently found between the tendon and the bone. The insertion of the trapezius exactly corresponds to the origin of the deltoid, and the two muscles are more or less connected by a thin aponeurosis over the spine and acromion process of the scapula. If both the trapezius muscles be exposed, it will be observed, that, between the sixth cervical and the third dorsal vertebra, their origin presents an aponeurotic space of an elliptical form.

Action.—The fixed point of the muscle is at the vertebral column, and all its fibres tend to raise the shoulder. The deltoid cannot raise the humerus to an angle of more than 50°: beyond this the elevation of the arm is principally effected by the action of the trapezius upon the scapula. It is necessarily in strong action when a weight is born upon the shoulders.

102. The *ligamentum nuchæ* is a structure consisting of dense fibrous tissue, which extends from the spine of the occiput to the spinous process of the last cervical vertebra. In some subjects it is difficult to distinguish it from the aponeurosis of the trapezius which arises from it; in others it is more conspicuous, and may be traced down to the spinous processes of the five or six lower cervical vertebræ, forming a more or less complete partition between the muscles at the back of the neck. It is a rudiment of the great elastic cervical ligament of quadrupeds which sustains the weight of the head.

105. The *latissimus dorsi* is a broad flat muscle which occupies the lumbar and the lower half of the dorsal region, and thence extends to the arm, where it forms part of the posterior boundary of the axilla. It arises by tendinous fibres from the posterior third of the external margin of the crest of the ilium, from a broad aponeurosis in the lumbar region called the fascia lumborum, from the spinous processes of the six inferior dorsal vertebræ, beneath the trapezius, and, lastly, from the three or four lower ribs by fleshy digitations, which correspond with those of the external oblique muscle of the abdomen. The upper fibres pass almost transversely outwards over the inferior angle of the scapula; those lower down ascend, gradually increasing in obliquity, while those which arise from the ribs are nearly vertical. In this way, all the fibres converge towards the axilla, where they form a thick muscle, which folds beneath the teres major, and is inserted by a broad flat tendon into the bottom of the bicipital groove of the humerus. The tendon is about two inches broad, and lies in front of that of the teres major, from which it is separated by a large *bursa*. Its lower part receives the transverse muscular fibres, and its upper part those which are more vertical, so that the muscle has a somewhat twisted appearance at the axilla. The tendon sends off an expansion to the fascia of the arm.

The latissimus dorsi often receives a distinct accessory slip from the inferior angle of the scapula.

Action.—It draws the humerus inwards and backwards: it also co-operates with the pectoralis major in pulling any object towards the body: if the humerus be the fixed point, it will raise the body, as in the act of climbing. The tranverse fibres of the muscle keep the inferior angle of the scapula in proper position. It sometimes happens that the scapula slips above the muscle: this displacement is readily recognized by the unnatural projection of the lower angle of the bone, and the impaired movements of the arm.

Between the base of the scapula, the trapezius, and the upper border of the latissimus dorsi, a triangular space is observed in certain positions of the arm, in which the lower fibres of the rhomboideus major, and part of the sixth intercostal space, are exposed.

Immediately above the crest of the ilium, between the free margins of the latissimus dorsi and external oblique muscles, there is commonly an interval in which the internal oblique is exposed.

106. The *fascia lumborum* is a dense shining aponeurosis in the lumbar region, thin and pointed at its upper part, broader and very strong at its lower. It consists of an intertexture of tendinous fibres, which are attached to the spines of the six or seven lower dorsal, all the lumbar and sacral vertebræ, and to the posterior part of the crest of the ilium. It is the common bond of attachment of the latissimus dorsi, the serratus posticus inferior, and the internal oblique and transverse muscles of the abdomen, and it forms the posterior part of the sheath of the great erector spinæ. Make a vertical incision through the fascia, and reflect it in order to see how inseparably it is connected on the outer side of the erector spinæ with the tendons of the internal oblique and transversalis which pass in front of the erector spinæ to the transverse processes of the lumbar vertebræ.

Reflect the trapezius from its origin. On its under surface will be observed the ramifications of a small artery, called the *superficialis colli* (a branch of the posterior scapular). A large nerve, the *spinal accessory,* also enters its under surface near the clavicle, and then divides into filaments, some of which ascend, others descend in its substance.

107. The *spinal accessory nerve* is one of the three divisions of the eighth pair of cerebral nerves. It arises from the posterior and lateral part of the cervical portion of the spinal cord by several roots, of which the lowest are opposite the fourth cervical vertebra. Formed by the union of these roots, the nerve enters the skull through the foramen magnum, and leaves it again through the foramen jugulare. It then descends behind the internal jugular vein, traverses obliquely the upper third of the sterno-mastoid muscle, and crosses the posterior triangle of the neck to reach the trapezius, in which it terminates.

The trapezius is also supplied by one or two branches of the cervical plexus, which communicate in its substance with the nervus accessorius.

Beneath the trapezius there remain to be examined four muscles

connected with the scapula, namely, the levator anguli scapulæ, the omo-hyoideus, and the rhomboideus major and minor. In order to clean these muscles, the scapula must be adjusted so as to stretch their muscular fibres.

108. The *levator anguli scapulæ* is situated at the posterior and lateral part of the neck. It arises by three or four tendons from the posterior tubercles of the transverse processes of the three or four upper cervical vertebræ. The tendons are situated between those of the scalenus posticus in front, and the splenius colli behind. That portion of the muscle which comes from the atlas is always the largest, and is frequently attached to the bone by fleshy fibres. The muscular slips to which the tendons give rise, unite and form a single muscle, which descends backwards down the side of the neck, and is inserted into the posterior border of the scapula between its spine and superior angle. Its *action* is to raise the posterior angle of the scapula; as, for instance, in shrugging the shoulders.

One or two branches of the cervical plexus of nerves enter the upper part of the levator anguli scapulæ; sometimes there is a distinct nerve for each slip of the muscle. Its scapular end is also supplied by a filament from a nerve of considerable size which lies beneath it, and passes on to supply the rhomboïd muscles.

109. The *rhomboideus major* and *minor* are two flat muscles which extend rather obliquely from the spinous processes of the vertebræ to the base of the scapula. They often appear like a single muscle, but, commonly, there is a division between them. The *rhomboideus minor*, situated the higher of the two, arises by a thin aponeurosis from the spinous processes of the last cervical and the first dorsal vertebra, and is inserted into the base of the scapula opposite its spine. The *rhomboideus major* arises by tendinous fibres from the spinous processes of the four or five upper dorsal vertebræ, and from the interspinous ligaments, and is inserted by fleshy fibres into the base of the scapula between its spine and inferior angle. In some cases the middle fibres are not inserted immediately into the bone, but into a thin tendon which runs parallel with the base of the scapula, adhering to it only at both ends. The *action* of these muscles is to draw the scapula upwards and backwards, and fix it upon the chest.

The *nerve of the rhomboid muscles* is a branch of the fifth cervical nerve. It passes outwards beneath the lower part of the levator anguli scapulæ, to which it sends a filament, and is lost in the under surface of the rhomboid muscles.

110. The *omo-hyoid* muscle extends from the scapula to the os-hyoides, and consists of two narrow muscular portions, connected by an intermediate tendon beneath the sterno-mastoid muscle. The posterior portion only can be seen in the present dissection. It arises from the superior costa of the scapula, close behind the notch, and from the ligament above the notch. From thence the slender muscle, concealed at first by the trapezius, passes forwards across the lower part of the neck, as far as the under surface of the sterno-mastoid muscle, where it changes its direction and ascends nearly vertically, to be attached to the os-hyoides at the junction of the body with the greater cornu. Thus the two portions of the muscle form beneath the sterno-mastoid an obtuse angle of which the apex is tendinous, and of which the angular direction is maintained by a strong layer of fascia, proceeding from the tendon to the first rib and the clavicle. Its *action* is to depress the os-hyoides. A more complete description of this muscle is given in the dissection of the neck.

111. The *supra-scapular artery*, (transversalis humeri,) a branch of the thyroid axis, will be found nearly parallel with, but rather below the posterior division of the omo-hyoid muscle. It runs near the under surface of the clavicle to the supra-scapular notch, through which it passes to supply the supra-spinatus and infra-spinatus muscles. It sends off in its course the *supra-acromial* branch, which perforates the trapezius, and ramifies upon the acromion, anastomosing with the other acromial arteries derived from branches of the axillary. The supra-scapular vein terminates either in the subclavian or in the external jugular vein.

The *supra-scapular nerve*, a branch of the fifth or sixth cervical nerve, takes the same course as the corresponding artery, and is distributed to the supra-spinatus and infra-spinatus muscles.

112. The *posterior scapular*, a large tortuous artery, is seen near the upper angle of the scapula. It is a continuation of the artery called the transversalis colli, which commonly arises from the

thyroid axis, but often separately from the subclavian either on the inner or the outer border of the scalenus anticus muscle, and runs backwards across the lower part of the neck, above, or between the trunk nerves of the brachial plexus, towards the posterior superior angle of the scapula. In this situation it takes the name of posterior scapular, and is seen pursuing its course beneath the levator anguli scapulæ and the rhomboid muscles under cover of the posterior border of the scapula. Divide the rhomboid muscles near their insertion and trace the artery to the inferior angle of the scapula, where it terminates in ramifications which supply the rhomboid and serratus magnus muscles.

Numerous muscular branches arise from this artery. One, called the *superficialis colli,* is given off near the upper angle of the scapula, and supplies chiefly the trapezius, in the substance of which it communicates with small branches which descend from the occipital artery.

The posterior scapular vein generally terminates in the subclavian or in the external jugular.

Divide the latissimus dorsi below the inferior angle of the scapula, and examine the serratus magnus. To see the full extent of this muscle, draw the posterior border of the scapula forcibly outwards, and divide the loose cellular tissue which intervenes between it and the ribs. The great abundance of cellular tissue in this situation is necessary for the free play of the scapula on the side of the chest.

113. The *serratus magnus* is a broad flat muscle which intervenes between the scapula and the ribs. It arises by distinct fleshy digitations from the external surfaces of the eight or nine upper ribs, about three inches, more or less, from their cartilages: a well-marked rib has generally an oblique ridge which indicates the attachment of the digitation. The digitations vary in size, and exceed by one the number of ribs from which they arise—since the second rib usually gives origin to two. The upper digitations also arise from aponeurotic arches over the two first intercostal spaces. The four lower ones, increasing in length and obliquity, correspond with those of the external oblique muscle of the abdomen. All the fibres pass backwards, converging to the posterior border of the

scapula. The upper portion of the muscle, which is the shortest and thickest, is inserted into the internal surface of the scapula, immediately below its superior angle; the middle, which is the weakest, is inserted by short aponeurotic fibres into the base of the scapula, between the rhomboid and subscapular muscles; the lower is inserted into the internal surface of the inferior angle of the scapula.

Action.—This is the most important of all the muscles which regulate the movements of the scapula on the chest; it counteracts all forces which tend to push the scapula backwards; by drawing the scapula forwards, it gives us two or three additional inches in the reach of the arm. Supposing the fixed point to be at the scapula, some anatomists ascribe to it the power of raising the ribs: hence Sir Charles Bell called it the external respiratory muscle, as opposed to the internal respiratory muscle, the diaphragm.

The nerve which supplies the muscle is a branch of the fifth and sixth cervical nerve: it descends along its outer surface (see § 15).

Divide the serratus magnus near the scapula, and remove the arm by sawing through the middle of the clavicle, and cutting through the axillary vessels and nerves. These should subsequently be tied to the coracoid process. After the removal of the arm, the precise insertion of the preceding muscles into the scapula should be carefully examined.

DISSECTION OF THE MUSCLES OF THE SHOULDER.

114. Remove the skin from the shoulder: the subcutaneous tissue over its anterior surface gives origin to a few fibres of the platysma myoides. A small absorbent gland is, in some few instances, found over the insertion of the deltoid.

The *cutaneous nerves of the shoulder* are derived partly from the branches of the cervical plexus which descend over the acromion, (see § 2), and partly from the circumflex nerve, of which one or two branches turn round the posterior border of the deltoid, and others, smaller, perforate the muscle, each accompanied by a small artery.

The thin layer of fascia observed upon the surface of the deltoid extends from the strong aponeurosis covering the muscles on the dorsum of the scapula, and is continuous with the fascia of the

arm. It dips down between the fibres of the muscle, dividing it into large bundles, and giving it a coarse appearance.

115. *The deltoid muscle.*—The great triangular muscle which covers the shoulder-joint is named deltoid, from its supposed resemblance to the Greek Δ reversed. It arises from the external third of the clavicle, from the outer border of the acromion, and from the spine of the scapula down to the triangular surface at its root. This origin, which corresponds precisely to the insertion of the trapezius, is tendinous and fleshy every where, except at the commencement of the spine of the scapula, where it is simply tendinous, and connected with the infra-spinous aponeurosis. The muscular fibres descend, the anterior backwards, the posterior forwards, and the middle perpendicularly, so that all converge to a tendon which is inserted into a rough surface a little above the middle of the outer part of the humerus. The insertion of the tendon cannot be fully seen till the muscle is reflected. It extends one inch and a half along the humerus, and terminates in a V shaped form, the origin of the brachialis anticus being on either side. Sometimes a few fibres of the pectoralis major are connected with its front border.

The arrangement of the muscular bundles composing the deltoid is peculiar; a peculiarity arising from its broad origin and its comparatively narrow insertion. They are collected into triangular bundles of different sizes, of which the greater number and the larger have their bases at the origin of the muscle, and their apices towards the insertion. The intervals between these are occupied by smaller triangular bundles with their bases downwards. This arrangement requires the interposition of tendons between the bundles for the attachment of the muscular fibres. Accordingly, we find that three or four tendons descend from the acromion, and give origin to those triangular bundles of which the bases are downwards: on the other hand, prolongations from the tendon at the humerus ascend into the muscle, and receive the insertion of those bundles of which the bases are upwards.

The action of the muscle is not only concentrated upon one point, but its power is also greatly increased, by this arrangement.

Action.—It raises the arm; but it cannot do so to a greater

angle than 60°. The elevation of the arm beyond this angle, is effected through the elevation of the shoulder by means of the trapezius. Its anterior fibres draw the arm forwards; the posterior, backwards.

Reflect the deltoid from its origin; observe the aponeurotic septa between its bundles of fibres; also the broad tendon of insertion into the humerus, and the pointed processes which ascend from it into the muscle. It is now seen how the muscle forms a complete protection to the shoulder-joint; how it covers the coraco-acromial ligament, the head, neck, and upper part of the humerus, as well as the tendons inserted into the greater tuberosity.

116. A *bursa* of very considerable size is situated between the deltoid, and the head of the humerus. It extends for some distance beneath the acromion and the coraco-acromial ligament, and covers the greater tuberosity of the humerus. In some instances it communicates by a wide opening with the shoulder-joint. Its use is to facilitate the movements of the head of the bone under the projecting arch, formed by the acromion and the coraco-acromial ligament. There may be two or more distinct bursal sacs over the head of the bone.

117. After the removal of the thin fascia from the under surface of the deltoid muscle, a complete view is obtained of the course of the circumflex artery and nerve. The *posterior circumflex artery* (see § 22) is given off from the axillary above the tendon of the latissimus dorsi: it passes backwards behind the surgical neck of the humerus, through a quadrilateral opening, bounded above by the subscapularis, below by the teres major, externally by the neck of the humerus, and internally by the long head of the triceps. The artery then winds round the neck of the bone to the under surface of the deltoid, in which its larger branches terminate, anastomosing with the ramifications of the anterior circumflex and acromial thoracic arteries.

From the posterior circumflex artery, a branch commonly descends in the substance of the long head of the triceps, to inosculate with the superior profunda; other small arteries ascend to supply the shoulder-joint and the head of the humerus, and some

perforate the deltoid, to join the delicate network of vessels upon the acromion.

a. The *circumflex nerve,* a branch of the axillary plexus, takes the same course as the artery, but is situated nearer to the head of the humerus. It sends a branch to the teres minor, one or two to the integuments of the shoulder, and terminates in the substance of the deltoid, in branches which accompany the ramifications of the circumflex artery. The proximity of this nerve to the head of the humerus explains the occasional occurrence of paralysis of the deltoid, after a dislocation of this bone into the axilla.

118. The muscles on the dorsum of the scapula are covered by a strong aponeurosis, which is firmly attached to the spine and borders of the bone. At the posterior edge of the deltoid, it divides into two layers, one of which passes over, the other under, the muscle. The superficial layer is continuous with the general fascia of the arm; the deep layer is continued over the head of the humerus to the short head of the biceps and coraco-brachialis muscles, and thence over the axillary vessels. Remove the aponeurosis from the muscles, so far as this can be done without injury to the muscular fibres which arise from its under surface.

119. The *infra-spinatus* muscle, triangular in form, arises by fleshy and tendinous fibres from the lower surface of the spine, and the greater part of the dorsum of the scapula, below the spine, excepting the neighbourhood of the neck; also from the back part of the strong fascia covering its surface, as well as that which separates it from the teres minor. The fibres converge to a tendon, which is at first contained in the substance of the muscle, and then proceeds over the capsular ligament of the shoulder-joint, to be inserted into the upper and back part of the greater tuberosity of the humerus.

120. The *teres minor* is a long narrow muscle, situated below the infra-spinatus, along the inferior border of the scapula. It arises from a smooth surface, about three inches long, on the dorsum of the scapula, close to the inferior border, and from its own fascial covering. The fibres ascend parallel with those of the infra-spinatus, and terminate in a broad flat tendon, which is contained

at first in the substance of the muscle, and then, passing behind the capsular ligament of the shoulder-joint, is inserted into the posterior and lower part of the greater tuberosity of the humerus. Some of the fibres of the muscle are attached directly into the bone. A branch of the circumflex nerve enters its inferior surface. A *bursa* sometimes intervenes between the tendon and the tuberosity.

The *action* of the infra-spinatus and teres minor is to rotate the humerus outwards.

121. The *teres major* muscle, situated below the teres minor, is closely connected with the latissimus dorsi, and extends from the inferior angle of the scapula to the humerus, contributing to form the posterior boundary of the axilla. It arises from the flat surface at the inferior angle of the dorsum of the scapula, and from the septum which separates it from the infra-spinatus and teres minor. The muscular fibres terminate upon a broad flat tendon, two inches or more in breadth, which is inserted into the inner edge of the bicipital groove of the humerus, behind the tendon of the latissimus dorsi. Its *action* is to draw the humerus backwards. By dissecting between the two tendons, it will be found that they are separated, near the groove, by a large *bursa*, and that the tendon of the latissimus dorsi is inserted into the bottom of the groove. The tendon of the teres major descends lower than that of the latissimus dorsi, and has commonly a separate *bursa* between itself and the bone.

Remove the trapezius from its insertion into the clavicle and spine of the scapula, and we shall then expose a layer of fascia, which is attached to the margins of the supra-spinal fossa, and covers the supra-spinatus muscle. This fascia must be removed.

122. The *supra-spinatus* muscle arises from the posterior two-thirds of the supra-spinal fossa, and from the posterior part of its aponeurotic covering. It passes underneath the acromion, over the upper part of the shoulder-joint, and is inserted by a strong broad tendon into the highest part of the greater tuberosity of the humerus. To obtain a good view of its insertion, the acromion process should be sawn off near the neck of the scapula. The tendon lies concealed in the muscle, and is closely connected with

the capsule of the joint. *Action.*—It assists the deltoid in raising the arm.

123. The *subscapularis* muscle is covered by a thin layer of fascia, which is attached to the borders of the scapula. It is triangular, and occupies the subscapular fossa. It arises from the posterior three-fourths of the fossa, from three or four tendinous septa attached to the oblique ridges on its surface, and from the axillary border of the bone. The bundles of the muscle converge towards the neck of the scapula, where they terminate upon three or four tendons, which are concealed amongst the muscular fibres, and are inserted into the lesser tuberosity of the humerus. Its broad insertion is closely connected with the capsule of the shoulder-joint, which it completely protects upon its inner side. Some of the fibres of the thick inferior border of the muscle are inserted fleshy into the neck of the humerus below the tuberosity. Its *action* is to rotate the humerus inwards.

The nerves (two or three in number) which supply the subscapularis are derived from the great cord which gives off the circumflex and musculo-spiral nerves.

The coracoid process, with the coraco-brachialis and short head of the biceps, form a kind of arch, under which the tendon of the subscapularis plays. There are several *bursæ* about the tendon. There is one of considerable size on the upper surface of the tendon, to facilitate its motion beneath the coracoid process and the coraco-brachialis: this sometimes communicates with the large bursa under the deltoid. Another is situated between the tendon and the root of the coracoid process. A third is situated between the tendon and the capsule of the joint, and almost invariably communicates with it. In some subjects the last two bursæ are united into one.

Reflect the muscles from the surfaces of the scapula, in order to trace the arteries which ramify upon the bone. Observe that a few fibres from each are lost upon the capsular ligament of the shoulder-joint. These fibres prevent the capsule from folding inwards during the movements of the head of the humerus upon the glenoid cavity.

124. Trace the continuation of the *supra-scapular artery* (see § 111). It passes above, or, less frequently, through the notch of the scapula, into the supra-spinal fossa; sends a branch to the supra-spinatus, and another to the shoulder-joint; and then descends over the neck of the scapula into the fossa below the spine, where it inosculates directly with the dorsalis scapulæ. Its numerous branches ramify upon the bone, and supply the infra-spinatus and teres minor muscles.

The supra-scapular nerve passes most frequently through the notch of the scapula, accompanies the corresponding artery, and supplies the supra and infra-spinatus muscles.

125. The *dorsal branch of the infra-scapular artery* (dorsalis scapulæ, see § 20) passes backwards through a triangular interval, bounded superiorly by the subscapularis, inferiorly by the teres major, and in front by the long head of the triceps. Having reached the dorsum of the scapula, it ascends, close to the bone, and anastomoses with the supra-scapular artery. It sends a branch, which runs between the origins of the teres major and minor, to the inferior angle of the scapula, and another which ramifies in the subscapular fossa.

The frequent communications about the scapula between the branches of the subclavian and axillary arteries, would furnish a free current of blood to the arm if the subclavian were tied above the clavicle.

126. *Triceps extensor cubiti.*—The origins of this muscle, which were only partially seen in the dissection of the upper arm (see § 38), should now be more fully examined. The long head is attached to a rough surface about an inch long, immediately below the glenoid cavity of the scapula, by a strong tendon which is thickest at its upper part, where it is connected with the capsule of the shoulder-joint. The tendon divides into two layers, of which the internal is prolonged for some distance, to afford increased surface for the origin of muscular fibres. The long head then descends, between the teres major and minor, along the posterior part of the humerus.

The second or external head arises, by aponeurotic fibres, from

the outer and posterior part of the humerus, commencing at a point below the insertion of the teres minor, and descending down to the middle of the bone; also from the upper two-thirds of the external intermuscular septum.

The third or internal head arises from the inner and posterior part of the humerus, commencing at a point below the teres major, and extending down to the elbow; also from the internal intermuscular septum. The precise origin of these heads from the humerus may be ascertained by following the superior profunda artery and musculo-spiral nerve, which intervene between them. The three portions of the muscle terminate upon a broad tendon, which covers the back of the elbow-joint, and is inserted into the summit and sides of the olecranon; it is also connected with the fascia on the back of the fore-arm. Between the tendon and the olecranon is placed a *bursa,* commonly of small size, but sometimes so large as to extend upwards behind the capsule of the joint: in some rare instances, a communication has been seen between them.

The tendon of the triceps commences as a broad expansion high up in the muscle, and is subcutaneous for several inches above the elbow. It receives the muscular fibres of the long head chiefly along the inner part of its superficial surface, nearly down to the olecranon. The fibres of the external head terminate upon the higher part of its deep surface, and those of the internal head upon the lower part. A few of the muscular fibres are implanted directly into the olecranon, and some of them pass behind the external condyle to the back of the fore-arm, and are inseparably united with a muscle called the anconeus. The *action* of the triceps is to extend the fore-arm.

By dividing the triceps transversely a little above the elbow, and turning down the lower portion, it will be observed that some of the muscular fibres which arise from the humerus above the fossa for the olecranon terminate upon the capsule of the joint. They have been described by some anatomists as a distinct muscle, under the name of *subanconeus;* their use is to draw up the capsule, so that it may not be injured during extension of the arm. The

subanconeus is in this respect analogous to the subcruræus muscle of the thigh. Observe the *bursa* under the tendon, and the numerous arteries which ramify upon the back part of the capsule of the joint.

Trace the continuation of the superior profunda artery (see § 40) and musculo-spiral nerve (see § 39) round the posterior part of the humerus. They lie close to the bone, and are protected by an aponeurotic arch thrown over them by the external head of the triceps: here the nerve is placed between the two principal branches of the artery. Observe the branches given off by the nerve to each of the three portions of the triceps, and follow the long branch of the superior profunda artery through the substance of the triceps to the olecranon.

DISSECTION OF THE BACK OF THE FORE-ARM.

127. Remove the skin from the back of the fore-arm, hand, and fingers. Observe the subcutaneous *bursa* over the olecranon. It is commonly of considerable size, and, if distended, would appear nearly as large as a walnut. Another *bursa* is sometimes found a little lower down upon the ulna. A subcutaneous *bursa* is generally placed over the internal condyle, and another over the external. A *bursa* is also situated over the styloid process of the ulna; this sometimes communicates with the sheath of the extensor carpi ulnaris. Small *bursæ* are sometimes developed in the cellular tissue over each of the knuckles.

The cutaneous veins from the back of the hand and fore-arm join the venous plexus at the bend of the elbow (see § 45).

128. *Subcutaneous nerves of the back of the fore-arm.*—They are the external cutaneous branches of the musculo-spiral nerve, the posterior branch of the internal cutaneous nerve (see § 46), and slender filaments from the external cutaneous (see § 34). The greater number of these nerves may be traced down to the back of the wrist.

129. *Subcutaneous nerves on the back of the hand, thumb, and fingers.*—The skin on the back of the hand is united to the subjacent tendons by an abundance of loose cellular tissue, in which

we find large veins, and branches of the radial (see § 59, *a b*) and ulnar nerves (see § 62 *a*). The veins are generally situated beneath the nerves.

The dorsal branch of the ulnar nerve passes very obliquely beneath the tendon of the flexor carpi ulnaris, and over the internal lateral ligament of the wrist; and divides upon the back of the hand into filaments, which become the dorsal nerves of the little finger, the ring finger, and the ulnar side of the middle finger.

The radial nerve passes obliquely beneath the tendon of the supinator longus, and subdivides into branches, which supply both sides of the back of the thumb and fore-finger, and the radial side of the middle finger. This last branch always communicates with a filament from the ulnar nerve.

The relative share which the radial and ulnar nerves take in supplying the fingers, is not the same in all cases. Under any arrangement, the thumb and each finger has two dorsal nerves, one on either side, of which the terminal branches reach the root of the nail. They supply filaments to the skin on the back of the finger, and have frequent communications with the palmar digital nerves. In some instances, one or more of the dorsal nerves do not extend beyond the first phalanx; their place is then supplied by a branch from the palmar nerve.

131. The *fascia on the back of the fore-arm* is composed of fibres interlacing in various directions, and is thicker and stronger than that upon the front surface of the fore-arm. It is attached to the two condyles of the humerus and to the olecranon, and is strengthened by an expansion from the tendon of the triceps. Along the fore-arm it is attached to the ridge on the posterior part of the ulna. Its upper third gives origin to the fibres of the muscles beneath it, and separates them by septa, to which their fibres are also attached.

Posterior annular ligament.—This should not be considered as a distinct ligament, but rather as a part of the fascia of the fore-arm, strengthened by oblique aponeurotic fibres near the back of the wrist in order to confine the extensor tendons. These fibres are firmly attached to the styloid process of the radius, and thence pass obliquely inwards to the inner side of the wrist, where they

are connected with the pisiform bone and the anterior annular ligament of the carpus. Observe that they pass below the styloid process of the ulna, to which they are in no way attached, otherwise the rotation of the radius would be impeded.

From the deep surface of this so-called ligament, processes are attached to the ridges on the back of the radius, so as to form as many as six distinct sheaths for the passage of the extensor tendons. Counting from the radius towards the ulna, the first sheath contains the tendons of the extensor ossis metacarpi and the extensor primi internodii pollicis; the second contains the tendons of the extensor carpi radialis longior and brevior; the third contains the tendon of the extensor secundi internodii pollicis; the fourth contains the tendons of the indicator and the extensor communis digitorum; the fifth contains the tendon of the extensor minimi digiti; and the sixth, the tendon of the extensor carpi ulnaris. All the sheaths are lined by synovial membranes, to facilitate the play of the tendons. In a few instances, one or more of them communicate with the wrist-joint.

The *fascia of the metacarpus* consists of a thin fibrous layer continued from the posterior annular ligament. It separates the extensor tendons from the subcutaneous veins and nerves, and is attached to the radial side of the second metacarpal bone, and the ulnar side of the fifth.

131. *Superficial muscles on the back of the fore-arm.*—The fascia must be removed from the muscles, so far as this can be done without injuring the muscular fibres which arise from its under surface. Preserve the posterior annular ligament. The following muscles are now exposed, and should be examined in the order in which they are placed, proceeding from the radial to the ulnar side of the fore-arm:—

The supinator radii longus (already described, § 54).
The extensor carpi radialis longior.
The extensor carpi radialis brevior.
The extensor communis digitorum.
The extensor minimi digiti.
The extensor carpi ulnaris.
The anconeus.

A little below the middle of the fore-arm, the extensors of the wrist and fingers diverge from each other, leaving an interval, in which are seen the three extensors of the thumb—the extensor ossis metacarpi pollicis, the extensor primi internodii pollicis, and the extensor secundi internodii pollicis. The two former cross the radial extensors of the wrist, and pass over the lower third of the radial border of the fore-arm; a small portion of the latter commonly appears on the outer side of the extensor communis digitorum.

Between the second and third extensors of the thumb, we observe a part of the lower end of the radius, which is not covered either by muscle or tendon. This subcutaneous portion of the bone is immediately above the prominent tubercle in the middle of its lower extremity, and, since it can be easily felt through the skin, it presents a convenient place for examination in doubtful cases of fracture.

132. The *extensor carpi radialis longior* muscle is partly covered by the supinator radii longus. It arises from the lower third of the ridge leading to the external condyle of the humerus, and from the intermuscular septum which separates it from the triceps. The muscle descends over the front surface of the capsule of the elbow-joint, along the outer side of the fore-arm, and terminates about, or a little above, the middle, in a broad flat tendon, which passes beneath the extensor ossis metacarpi and primi internodii pollicis, traverses a groove on the outer and back part of the radius, lined by a distinct synovial membrane, and is inserted into the posterior part of the carpal end of the metacarpal bone of the index finger. Previously to its insertion, the tendon lies on the capsular ligament of the wrist, and is crossed by the extensor secundi internodii pollicis. Reflect this muscle from its origin, in order to see the following, which is situated beneath it.

133. The *extensor carpi radialis brevior* muscle arises from the external condyle, from part of the external lateral ligament of the elbow, and from a strong aponeurosis, which is continued for some distance on its deep surface. The muscular fibres terminate near the middle of the fore-arm, upon the under surface of a broad flat tendon, which descends, covered by that of the extensor carpi

radialis longior, beneath the first two extensors of the thumb. Near the wrist, the tendon becomes more superficial, and traverses a groove on the back of the radius, on the same plane with that of the long radial extensor, but lined by a separate synovial membrane. The tendon then passes over the wrist-joint, where it is crossed by the third extensor of the thumb, and is inserted into the carpal end of the metacarpal bone of the middle finger. A *bursa* is generally found between the tendon and the bone.

Near its origin, the extensor carpi radialis brevior is in contact with the outer part of the capsule of the elbow-joint. In the upper third of the fore-arm, it lies upon the supinator radii brevis, a small *bursa* intervening near the head of the radius; in the lower two-thirds of the fore-arm it covers the insertion of the pronator teres, and the back of the radius. The *action* of the radial extensors of the wrist is implied by their name.

134. The *extensor digitorum communis* muscle arises from the common tendon attached to the external condyle, from the septa between it and the contiguous muscles, and from its strong fascial covering. About the middle of the fore-arm the muscle divides into three or four fleshy slips, terminating in as many flat tendons, which pass beneath the posterior annular ligament, through a groove on the back of the radius lined by synovial membrane. On the back of the hand they become broader and flatter, and diverge from each other towards the metacarpal joints of the fingers, where they become thicker and narrower, and give off on each side a fibrous expansion, which covers the sides of the joint. Over the first phalanx of the finger, each tendon again spreads out, receives the expanded tendons of the lumbricales and interossei muscles, and divides at the second phalanx into three portions, of which the middle is inserted into the upper end of the second phalanx; the two lateral, reuniting over the lower end of the second phalanx, are inserted into the upper end of the third.

A small *bursa* is generally found between the tendons and the metacarpal joints; and a patella-like piece of cartilage, or even bone, is in some few instances developed in the central portion of the tendon as it passes over the second joint of the finger.

Observe the oblique aponeurotic slips which connect the tendons

on the back of the hand. They are subject to great variety. The tendon of the index finger is commonly free; it is situated on the radial side of the proper indicator tendon, and becomes united with it at the metacarpal joint.

The tendon of the middle usually receives a slip from that of the ring finger. The tendon of the ring finger generally sends a slip to the tendons on either side of it, and in some cases entirely furnishes the tendon of the little finger. Thus the ring finger is incapable of independent extension.

The tendon of the little finger ordinarily sends a slip to the next tendon, and unites at the metacarpal joint with the radial border of the extensor proprius minimi digiti.

Action.—It is not only a general extensor of the fingers, but it can extend some of the phalanges independently of the rest: *e. g.* it can extend the first phalanges while the second and third are flexed; or it can extend the second and third phalanges during flexion of the first.

135. The *extensor digiti minimi or auricularis* is a long slender muscle situated between the extensor digitorum communis and the extensor carpi ulnaris. It arises from the common tendon from the external condyle, from the septa between it and the contiguous muscles, and from its own fascial covering. Its slender tendon of insertion continues to receive fleshy fibres nearly down to the annular ligament, beneath which it passes, immediately behind the joint between the radius and ulna, in a special sheath lined by synovial membrane.

At the first joint of the little finger, the tendon is joined by that of the common extensor, and both expand upon the dorsal surface of the first and second phalanges, terminating in the same manner as the extensor tendons of the other fingers.

136. The *extensor carpi ulnaris* is situated along the ulnar border of the back of the fore-arm. It arises from the common tendon from the external condyle, from the middle third of the posterior surface of the ulna, from the septum between it and the extensor minimi digiti, and from the aponeurosis of the fore-arm. The fibres descend longitudinally down the posterior border of the ulna, and terminate upon a strong broad tendon, which commences

high up in the substance of the muscle, and receives fleshy fibres on its deep surface nearly as low as the end of the ulna. The tendon then traverses a distinct groove on the back of the ulna, close to the styloid process, and is inserted into the inner and posterior part of the carpal end of the metacarpal bone of the little finger. Below the styloid process of the ulna, the tendon passes beneath the posterior annular ligament, over the back of the wrist, and is here contained in a very strong fibrous canal, which is attached to the back of the cuneiform, pisiform, and unciform bones, and is lined by a continuation from the synovial membrane in the groove of the ulna. The *action* of this muscle is to extend the hand, and incline it towards the ulnar side.

In pronation of the fore-arm, the lower end of the ulna projects between the tendons of the extensor carpi ulnaris and the extensor minimi digiti. A subcutaneous *bursa* is sometimes found above the bone in this situation; another is more deeply seated between the bone and the fascia, and in some instances communicates with the joint beneath it.

137. The *anconeus* is a small triangular muscle situated at the outer and back part of the elbow. It is covered by a strong layer of fascia, derived from the tendon of the triceps, and appears like a continuation of that muscle. It arises from the posterior part of the external condyle of the humerus, by a tendon which descends for some distance along the radial side of the muscle. The upper fibres, continuous with those of the triceps, pass transversely inwards, to be attached to the olecranon; the lower, increasing successively in length and obliquity, are inserted into the triangular surface, on the upper fourth of the outer part of the ulna. Part of the under surface of the muscle is in contact with the capsule of the elbow-joint. A *bursa* is sometimes found between its tendon and the head of the radius. Its *action* is to assist in extending the fore-arm.

138. *Deeper seated muscles on the back of the fore-arm.*—Detach from the external condyle the extensor carpi radialis brevior, the extensor digitorum communis, the extensor minimi digiti, and the extensor carpi ulnaris. Observe the small *bursa* which is situated between the common tendon of these muscles and that of

the supinator radii brevis beneath them. In reflecting the superficial muscles, preserve the vessels and nerves which enter their under surface. The deeper seated muscles now exposed are—

The supinator radii brevis,
extensor ossis metacarpi pollicis,
extensor primi internodii pollicis,
extensor secundi internodii pollicis,
extensor proprius indicis or indicator.

139. The *supinator radii brevis* muscle is situated over the upper third of the radius. It arises by tendinous fibres from the external lateral ligament of the elbow-joint, from the annular ligament surrounding the head of the radius, from an oblique ridge situated on the upper fourth of the outer surface of the ulna, below the insertion of the anconeus, and by fleshy fibres from a triangular excavation below the lesser sigmoid notch of the ulna. The muscular fibres turn over the neck and upper part of the shaft of the radius, and are inserted fleshy into the upper third of the outer surface of this bone, as far forwards as the ridge leading from the tubercle obliquely downwards and outwards to the insertion of the pronator teres. Some of the upper fibres embracing the neck of the radius are inserted above the tubercle.

The muscle is perforated obliquely by the deep branch of the musculo-spiral nerve (see § 39), and its upper part is in contact with the capsule of the elbow-joint. *Action.*—It is the most powerful supinator of the fore-arm, some of its fibres acting at nearly a right angle to the axis of the radius.

140. The *extensor ossis metacarpi pollicis* is the strongest of the extensor muscles of the thumb. It arises by a pointed extremity from the posterior surface of the ulna below the supinator brevis, with which it is generally more or less united; also by short aponeurotic fibres from a ridge on the middle third of the bone, and from the posterior surface of the radius, a little above its middle, as well as from the interosseous ligament. The muscle descends obliquely over the radius, crosses the radial extensors of the wrist about three inches above the carpus, and terminates in a tendon, which passes along a groove, lined by synovial membrane, on the

outer part of the lower end of the radius, and is inserted into the radial side of the base of the metacarpal bone of the thumb and the os trapezium. It also sends off a fascia, which covers the abductor pollicis. Between the tendon and the os trapezium there is often a small *bursa,* which in some instances communicates with the joint beneath.

141. The *extensor primi internodii pollicis* lies on the ulnar side of the preceding muscle, and takes the same direction. It arises from the posterior surface of the radius, below the extensor ossi metacarpi pollicis, from the interosseous ligament, and from the ulna. The thin muscle turns over the radial extensors of the wrist, and terminates upon a tendon which passes beneath the annular ligament, through the groove on the outer part of the radius, and is inserted into the radial side of the first phalanx of the thumb.

142. The *extensor secundi internodii pollicis* arises from the middle third of the posterior surface of the ulna, and from the interosseous ligament. The tendon upon which the muscle terminates receives fleshy fibres as low as the wrist, passes beneath the annular ligament in a distinct groove on the back of the radius, proceeds over the metacarpal bone and the first phalanx of the thumb, and is inserted into the base of the last phalanx.

The tendons of the three extensors of the thumb may be easily distinguished in one's own hand. The extensor ossis metacarpi, and primi internodii pollicis, cross obliquely over the radial artery, in the situation where it lies on the external lateral ligament of the carpus; the extensor secundi internodii pollicis crosses the artery just before it sinks into the palm, between the first and second metacarpal bones, and is a good guide to the vessel. The *action* of the three extensors of the thumb is implied by their names.

143. The *extensor indicis,* or *indicator* muscle, arises from the posterior surface of the ulna, and from the inter-osseous ligament. The tendon upon which the muscle terminates receives fleshy fibres as low as the wrist, passes beneath the posterior annular ligament, in the same groove on the back of the radius, with the tendons of the extensor digitorum communis. It

then proceeds over the back of the hand to the first phalanx of the index finger, where it is united to the ulnar border of the common extensor tendon. By the *action* of this muscle, the index finger can be extended independently of the others.

144. *Relative position of the tendons over the back of the radius and ulna.* Proceeding from the ulnar towards the radial side of the wrist, the tendons are situated in the following order, beneath the posterior annular ligament:—

The tendon of the—

Extensor carpi ulnaris, in a groove on the lower end of the ulna;

Extensor minimi digiti, over the articulation between the radius and ulna;

Extensor digitorum communis, with the indicator, in the first broad groove on the radius;

Extensor secundi internodii pollicis, in a narrow groove on the radius on the ulnar side of the middle tubercle.

Extensor carpi radialis brevior, } in the second broad groove on the
Extensor radialis carpi longior, } radius.

Extensor primi internodii pollicis, } in a groove on the outer side
Extensor ossis metacarpi pollicis, } of the radius.

145. *Synovial sheaths of the extensor tendons.*—The tendon of the extensor carpi ulnaris is contained in a separate tendinous sheath in its passage along the groove of the ulna and the back of the wrist. Make a longitudinal opening in the sheath, to see the synovial lining, and the fold which is reflected over the tendon. This synovial sheath is nearly two inches long, beginning about half an inch above the styloid process of the ulna, and terminating at the insertion of the tendon.

a. The tendon of the extensor minimi digiti has a separate tendinous sheath, formed entirely by the posterior annular ligament, and is situated immediately behind the articulation, between the radius and ulna. Its synovial sheath is from two to three inches long, and extends for some distance along the back of the hand.

b. The tendons of the extensor digitorum communis with the indicator are contained in the same groove on the back of the radius. The groove is lined by a synovial membrane, which is

reflected over each of the tendons, and accompanies them for a short distance on the back of the hand. The extent of the synovial sheath is about two inches.

c. The tendon of the extensor secundi internodii pollicis is contained in a narrow well-marked groove on the back of the radius. Its synovial sheath varies from two to three inches in length, and extends, in some instances, from the radius down to the first phalanx of the thumb. In the situation where this tendon crosses the extensor tendons of the carpus, a narrow communication is frequently formed between their respective synovial sheaths.

d. The tendons of the extensor carpi radialis brevior and longior are contained in the same groove on the back of the radius. Generally, there is a distinct synovial sheath for each tendon: that of the extensor brevior is about two inches in length, extending from the groove nearly to the insertion of the tendon; that of the extensor longior is commonly not more than one inch in extent.

e. The tendons of the extensor primi internodii pollicis and ossis metacarpi pollicis are contained in a groove on the outer part of the radius. Each has most commonly a separate synovial sheath, varying from two to two and a half inches in extent.

In some rare instances it is observed that one or more of the synovial sheaths of the extensor tendons communicate with the cavity of the wrist-joint.

146. The *posterior interosseous artery* is derived from the ulnar by a common trunk with the anterior interosseous (see § 67), and supplies the muscles on the back of the fore-arm. It passes between the radius and ulna above the interosseous membrane, and appears between the supinator radii brevis and the extensor ossis metacarpi pollicis. After supplying branches to all the muscles in this situation, the artery descends, much diminished in size, between the superficial and deep layer of muscles to the wrist, where it inosculates with the carpal branches of the anterior interosseous and those of the radial and ulnar arteries.

a. But the largest branch of this artery is the *recurrent*. It ascends beneath the anconeus muscle to the space between the external condyle and the olceranon, where it inosculates with the branch of the superior profunda, which descends in the substance

of the triceps muscle. It furnishes several branches to the muscles, and others which penetrate the capsule of the joint, and ramify upon the synovial membrane.

In the lower part of the back of the fore-arm, a branch of the anterior interosseous artery is seen passing through the interosseous membrane to reach the back of the wrist (see § 67).

147. The nerve which supplies the muscles on the back of the fore-arm is the *posterior muscular* (posterior interosseous of authors), a branch of the musculo-spiral (see § 39). It passes obliquely through the supinator radii brevis, and descends between the superficial and deep layer of muscles on the back of the fore-arm, sending to each a filament, generally in company with a branch of the posterior interosseous artery. It sends a branch to the extensor carpi radialis brevior, and supplies the supinator brevis in passing through its substance. The supinator radii longus and the extensor carpi radialis longior are supplied by distinct branches from the musculo-spiral (see § 39, *d*).

The continuation of the posterior muscular nerve sends a branch to the extensor secundi internodii pollicis and to the indicator, and then descends beneath the tendons of the extensor digitorum communis to the back of the wrist. In this situation the nerve forms a kind of gangliform enlargement, from which filaments are sent to the carpal and metacarpal joints.

On reviewing the distribution of the musculo-spiral nerve, we find that its branches supply the extensor and supinator muscles of the fore-arm, and the extensors of the hand, thumb, and fingers. Its cutaneous branches supply the lower part of the outer side of the upper-arm, the back of the fore-arm (see § 39, *c*), and the outer half of the back of the hand, as well as the back of the thumb and the two next fingers (see § 59).

148. *Course and branches of the radial artery on the back of the hand.*—Trace the continuation of the radial artery over the external lateral ligament of the carpus, beneath the extensor tendons of the thumb, to the upper part of the interval between the first and second metacarpal bones, where it sinks betweeen the origin of the abductor indicis muscle, and, entering the palm, forms the deep palmar arch (see § 98). In this part of its course it is

crossed by filaments of the radial nerve; observe, also, that the tendon of the extensor secundi internodii pollicis passes over it immediately before it sinks into the palm. It supplies the following small branches to the back of the hand.

a. Posterior carpal artery.—This branch passes across the carpal bones beneath the extensor tendons. It inosculates with the termination of the anterior interosseous artery (see § 67), and sometimes with a corresponding branch from the ulnar artery. The carpal artery commonly sends off small branches, called the *dorsal interosseous,* which descend along the third and fourth interosseous spaces, beneath the extensor tendons, inosculating near the carpal ends of the metacarpal bones with the perforating branches from the deep palmar arch (see § 98, *a*).

b. The *dorsal interosseous artery* of the second space (sometimes called the metacarpal branch of the radial) is generally larger than the others. It descends over the second dorsal interosseous muscle to the cleft between the index and middle fingers, and terminates in small branches, some of which proceed along the back of the fingers, others inosculate with the palmar digital arteries.

c. The *dorsal arteries of the thumb* are two small branches which arise from the radial opposite the head of the first metacarpal bone, and run along the back of the thumb, one on either side. They are often absent.

d. The *dorsal interosseous artery of the first space* (commonly called the dorsal artery of the index finger), a branch of variable size, passes over the first interosseous muscle to the radial side of the back of the index finger.

These dorsal interosseous arteries supply the extensor tendons and their sheaths, the interosseous muscles, and the skin on the back of the hand and the first phalanges of the fingers.

149. Remove the tendons from the back and from the palm of hand: observe the deep palmar fascia which covers the interosseous muscles. It is attached to the ridges of the metacarpal bones, forms a distinct sheath for each interosseous muscle, and is continuous inferiorly with the transverse metacarpal ligament. On the back of the hand the interosseous muscles are covered by a thin fascia, which is attached to the adjacent borders of the metacarpal bones.

a. The *transverse metacarpal ligament* consists of strong bands of ligamentous fibres, which pass transversely between the digital extremities of the metacarpal bones of the fingers. These bands are intimately united to the fibro-cartilaginous ligament of the metacarpal joints, and are of sufficient length to admit of a certain degree of movement between the ends of the metacarpal bones.

Remove the fascia which covers the interosseous muscles, and separate the metacarpal bones by dividing the transverse metacarpal ligament. A *bursa* is frequently developed in the cellular tissue, between their digital extremities.

150. *Interosseous muscles.*—These muscles, so named from their position, extend from the sides of the metacarpal bones to the first phalanges and the extensor tendons of the fingers. In each interosseous space there are two, one of which is an abductor, the other an adductor of a finger. According to this arrangement there ought to be eight: but since the adductor pollicis (first palmar interosseous) is usually described as a separate muscle, there remain only seven, four of which, situated on the back of the hand, are called dorsal; the remainder, seen only in the palm, are called palmar.

Each *dorsal* interosseous muscle arises from the opposite sides of two metacarpal bones, but more extensively from the metacarpal bone of the finger which the muscle moves. From this double origin the fibres converge to a tendon, which commences in the middle of the muscle, passes between the metacarpal joints of the fingers, and is inserted into the side of the first phalanx: it is also connected by a broad expansion with the extensor tendon on the back of the finger. The two portions of the double origin are separated by the perforating branch of the deep palmar arch (see § 98, *a*).

The *first* dorsal interosseous muscle (abductor indicis) is larger than the others, and occupies the interval between the thumb and fore-finger. It arises from the upper half of the ulnar side of the first metacarpal bone, and from the entire length of the radial side of the second: between the two origins, the radial artery passes into the palm. Its fibres converge on either side to a tendon, which is inserted into the *radial* side of the first phalanx of the index finger and its extensor tendon.

The *second* dorsal interosseous muscle occupies the second metacarpal space. It is inserted into the radial side of the first phalanx of the middle finger and its extensor tendon.

The *third* and *fourth*, occupying the corresponding metacarpal spaces, are inserted, the one into the ulnar side of the middle, the other into the ulnar side of the ring finger.

Action.—If an imaginary line be drawn longitudinally through the middle finger, we shall find that all the dorsal interosseous muscles are abductors from that line; consequently, they separate the fingers from each other.

The *palmar interosseous muscles*.—It requires a careful examination to distinguish this set of muscles, because the dorsal muscles protrude with them into the palm. They are smaller than the dorsal, and each arises from the lateral surface of only one metacarpal bone, that, namely, connected with the finger into which the muscle is inserted. They terminate in small tendons, which pass between the metacarpal joints of the fingers, and are inserted, like the dorsal muscles, into the sides of the first phalanges and the extensor tendons on the back of the fingers.

The *first* palmar interosseous muscle arises from the ulnar side of the second metacarpal bone, and is inserted into the ulnar side of the index finger. The *second* and *third* arise, the one from the radial side of the fourth, the other from the radial side of the fifth metacarpal bone, and are inserted into the same sides of the ring and little fingers.

Action.—The palmar interosseous muscles are all adductors to an imaginary line drawn through the middle finger. They are, therefore, the opponents of the dorsal interosseous muscles, and move the fingers towards each other. Both palmar and dorsal interosseous muscles act with greater advantage when the fingers are extended.

DISSECTION OF THE LIGAMENTS.

151. JOINT BETWEEN THE CLAVICLE AND THE STERNUM.—The inner end of the clavicle articulates with a shallow excavation on the upper and outer part of the sternum. From the form of

the articular surfaces of the bones, it is plain that the security of the joint must depend upon the strength of its ligaments. There are two synovial membranes, and an intervening fibro-cartilage.

The *anterior sterno-clavicular ligament* consists of a broad band of ligamentous fibres, which pass obliquely downwards and inwards over the front of the joint, from the anterior border of the end of the clavicle to the anterior surface of the sternum.

A similar band, called the *posterior sterno-clavicular* ligament, extends over the back of the joint, from the posterior border of the clavicle to the posterior surface of the sternum.

The clavicles are connected by what is called the *inter-clavicular ligament.* It extends transversely above the notch of the sternum, and has a broad attachment to the upper border of each clavicle. Between the clavicles it is more or less attached to the sternum, so that it forms a curve with the concavity upwards.

The three ligaments just described are so closely connected, that, collectively, they form a complete fibrous capsule of great strength for the joint.

A ligament, called the *costo-clavicular* or *rhomboid,* connects the clavicle to the cartilage of the first rib. It ascends from the cartilage of the rib to a rough surface beneath the sternal end of the clavicle. Its use is to limit the elevation of the clavicle. There is such constant movement between the clavicle and the cartilage of the first rib, that a well-marked *bursa* is commonly found between them.

Inter-articular fibro-cartilage.—In order to see this, we must cut through the rhomboid, the anterior and posterior ligaments of the joint, and then raise the clavicle. It is nearly circular in form, and thicker at the circumference than the centre, in which there is sometimes a perforation. Inferiorly, it is attached to the cartilage of the first rib, close to the sternum; superiorly, to the upper part of the clavicle and the inter-clavicular ligament. Its circumference is inseparably connected with the fibrous capsule of the joint.

The joint is provided with two synovial membranes: one is placed between the articular surface of the sternum and the inner surface of the fibro-cartilage; the other, between the articular surface of the clavicle and the outer surface of the fibro-cartilage.

The probable purpose served by the fibro-cartilage is to adapt the articular surface of the sternum more accurately to the different movements of the clavicle. It also acts as a ligament, preventing the clavicle from being driven inwards towards the mesial line. The two synovial membranes greatly facilitate the motions of the joint.

Observe the relative form of the cartilaginous surfaces of the bones: that of the sternum is slightly concave in the transverse, and convex in the antero-posterior direction; that of the clavicle is the reverse.

The form of the articular surfaces and the ligaments of a joint being known, it is easy to understand the movements of which it is capable. The clavicle can move upon the sternum in a direction either vertical or horizontal: thus it admits of circumduction. These movements, though very limited at the sternum, become very considerable at the apex of the shoulder.

152. Connexion of the Clavicle with the Scapula.—The outer end of the clavicle articulates with the acromion, and is connected by strong ligaments to the coracoid process of the scapula.

Joint between the acromion and the clavicle.—The clavicle and the acromion articulate with each other by means of two flat oval cartilaginous surfaces, of which the planes are nearly vertical, and the greater diameters in the antero-posterior direction.

The *superior ligament*, a broad band of ligamentous fibres, strengthened by the aponeurosis of the trapezius, extends from the upper surface of the acromion to the upper surface of the clavicle.

The *inferior ligament*, of lesser strength, extends along the under surface of the joint from bone to bone.

An *inter-articular fibro-cartilage* is often found in this joint: it is incomplete, and seldom extends lower than the upper half. There is only one synovial membrane.

Coraco-clavicular ligament.—The clavicle is connected to the coracoid process of the scapula by two strong ligaments—the *conoid* and *trapezoid*, which, being continuous with each other, might fairly be considered as one. The *trapezoid* ligament is the more anterior. It arises from the back part of the upper surface of the

coracoid process, and ascends obliquely outwards to the lower surface of the clavicle near its outer end. The *conoid* ligament is fixed at its apex to the inner side of the root of the coracoid process, ascends vertically, and is attached by its base to the under surface of the clavicle, near the posterior border. There is commonly a *bursa* between the two ligaments when the clavicle and the coracoid process are in contact.

153. *Ligaments proper to the scapula.*—There are only two: the *coracoid* ligament, which is attached to the opposite margins of the supra-scapular notch, and the *coraco-acromial* or *triangular* ligament, which is attached by its apex to the acromion, and by its base to the outer border of the coracoid process. It is separated from the upper part of the capsule of the shoulder-joint by a large *bursa*, and an aponeurosis descends from its front border over the head of the humerus.

In a few rare instances the acromion is connected to the spine of the scapula by an intervening fibro-cartilage; or there may be a distinct articulating surface, provided with a capsular ligament and a synovial membrane.

154. SHOULDER-JOINT.—The articular surface of the head of the humerus, forming rather more than one-third of a sphere, moves upon the shallow glenoid cavity of the scapula, which is of an oval form, with the broader end downwards, and the long diameter nearly vertical. It is obvious that the security of the joint does not depend upon any mechanical contrivance of the bones, but rather upon the great strength and number of the tendons which surround it.

To admit the free motion of the head of the humerus upon the glenoid cavity, it is requisite that the *capsular ligament* of the joint be very loose and capacious. Accordingly we find that the head of the bone, when detached from its muscular connections, may be separated from the glenoid cavity to the extent of an inch, or even more, without laceration of the capsule. This explains the elongation of the arm observed in some cases in which effusion has taken place into the cavity of the joint; also in some cases of paralysis of the deltoid muscle.

The *capsular ligament* is attached, on the one hand, round the

circumference of the glenoid cavity; and, on the other, round the anatomical ~~surgical~~ neck of the humerus. It is strengthened on its upper and posterior surface by the tendons of the supra-spinatus, infra-spinatus, and teres minor muscles; its internal surface is inseparably connected with the broad tendon of the subscapularis, and inferiorly it is in contact with the long head of the triceps. Thus the circumference of the capsule is surrounded by tendons on every side, excepting a small space towards the axilla. If the humerus be raised, it will be found that the head of the bone rests upon this unprotected portion of the capsule; that is, between the tendons of the subscapularis and the long head of the triceps; and through this part of the capsule the head of the bone usually protrudes in dislocations into the axilla.

At the upper and inner side of the joint, a small opening, sometimes called the *foramen ovale*, is observable in the capsular ligament, through which the tendon of the subscapularis passes, and comes in contact with the synovial membrane.

The upper surface of the capsule is, moreover, strengthened by a strong band of ligamentous fibres, commonly called the *coraco-humeral* or *accessory ligament*. It is attached to the outer border of the root of the coracoid process, expands over the upper and outer surface of the capsule, with which it is inseparably united, and is fixed with it into the greater tuberosity of the humerus.

Open the capsule by a transverse incision through its axillary surface. By raising the head of the humerus, the tendon of the long head of the biceps will be seen at the upper part of the joint. It enters the joint through the groove between the two tuberosities, becomes slightly flattened, and passes over the head of the bone to be attached to the upper border of the glenoid cavity. It is loose and moveable within the joint; and it is said to act like a strap, supporting the head of the bone, and keeping it in accurate apposition with the glenoid cavity. In some cases, the tendon, having been ruptured by violence, has contracted an adhesion to the bicipital groove.

The tendon of the biceps does not perforate the synovial membrane of the joint. It is enclosed in a kind of tubular sheath,

which is reflected over it at its attachment to the glenoid cavity, and accompanies it for two inches down the groove of the humerus. During the earlier part of fœtal life it is connected to the capsule by a fold of synovial membrane, which subsequently disappears.

The margin of the glenoid cavity of the scapula is surrounded by a fibro-cartilaginous band of considerable thickness, called the *glenoid ligament.* This not only enlarges the cavity, but renders it a little deeper. Superiorly, it is continuous on either side with the tendon of the biceps; inferiorly, with the tendon of the triceps: in the rest of its circumference it is attached to the edges of the cavity.

Observe that the cartilage covering the head of the humerus is thicker at the centre than at the circumference. The reverse is the case in the glenoid cavity.

The *synovial membrane* lining the under surface of the capsule is reflected around the tendon of the biceps, and passes with it, in the form of a cul-de-sac, down the bicipital groove. On the inner side of the joint it always communicates with the bursa beneath the tendon of the subscapularis.

The shoulder-joint has a more extensive range of motion than any other joint in the body: it is, in fact, a kind of universal joint. It is capable of motion forwards and backwards; of adduction, abduction, circumduction, and rotation.

155. Elbow-joint.—Detach the brachialis anticus from the anterior, and the triceps from the posterior surface of the capsule of the joint. Remove the tendons attached to the condyles without injuring the lateral ligaments.

The elbow-joint is a perfect hinge. The larger sigmoid cavity of the ulna is accurately adapted to the trochlea upon the lower end of the humerus, admitting of simple flexion and extension; while the shallow excavation upon the head of the radius admits not only of flexion and extension, but also of rotation upon the rounded articular eminence (*capitellum*) of the humerus. The joint is secured by an anterior, a posterior, and two strong lateral ligaments. No ligament is attached to the head of the radius,

otherwise its rotatory movement would be impeded. It is simply surrounded by a ligamentous collar, called the annular ligament, within which it freely rolls.

Internal lateral ligament.—This is somewhat fan-shaped, and is made more conspicuous by bending the joint. Its apex is attached to the lower part of the internal condyle of the humerus: from this point the fibres radiate, and are inserted into the inner border of the greater sigmoid cavity of the ulna.

A transverse band of ligamentous fibres extends from the olecranon to the coronoid process, across a notch observable on the inner side of the sigmoid cavity: through this notch vessels pass into the joint.

External lateral ligament.—This is attached to the external condyle of the humerus; the fibres spread out as they descend, and are interwoven with the annular ligament, surrounding the head of the radius. Some of them are implanted into the anterior and the posterior borders of the lesser sigmoid cavity of the ulna.

The *anterior ligament* consists of a thin fibrous membrane, situated over the front of the joint. It is attached, superiorly, to the front of the lower end of the humerus; inferiorly to the annular ligament of the radius, and the border of the coronoid process of the ulna. Some of its fibres take an oblique, others a vertical direction.

The *posterior ligament* consists of a few thin ligamentous fibres, which extend across the fossa at the lower end of the back of the humerus.

These ligaments, collectively, form a continuous capsule round the elbow-joint.

The orbicular or *annular ligament of the radius* is attached to the anterior and the posterior border of the lesser sigmoid cavity of the ulna. With this cavity, it forms a complete collar, which encircles the head and upper part of the neck of the radius, without impeding its capability of rotation. The lower part of the collar is narrower than the upper, in order to fit the neck of the radius, and maintain it more accurately in its position. Its outer surface receives the attachment of the external lateral ligament.

Divide the ligament longitudinally, to see its attachment to the borders of the lesser sigmoid cavity.

Synovial membrane of the elbow-joint.—Open the joint by a transverse incision through the anterior ligament, and observe the relative adaptation of the cartilaginous surfaces of the bones. The synovial membrane lines the interior of the capsule, and forms a cul-de-sac between the head of the radius and its orbicular ligament. It is widest and most loose under the tendon of the triceps. Where the membrane is reflected from the bones upon the ligaments, there is more or less adipose tissue, particularly in the fossæ on the front and back part of the lower end of the humerus.

Observe that the head of the radius is in contact with the humerus only when the elbow-joint is flexed.

156. The *interosseous ligament* or *membrane* is an aponeurotic septum, which is stretched across the interval between the bones of the fore-arm, and of which the chief purpose is to afford an increase of surface for the attachment of muscles. The septum is deficient between the upper ends of the bones, in order to permit free rotation of the radius: it is also sometimes deficient between the lower ends. The fibres of which it is composed extend obliquely downwards from the ridge of the radius to the opposite ridge of the ulna. It is broader in the middle than at either end, and is perforated by several small vessels, but more especially by the dorsal branch of the anterior interosseous artery (see § 67).

The name of *round* or *oblique ligament* is given to a thin band of ligamentous fibres, which extends obliquely between the bones of the forearm in a direction contrary to those of the interosseous membrane. It is attached, superiorly, to the front surface of the ulna, near the outer side of the coronoid process; inferiorly, to the radius immediately below the tubercle. A *bursa* commonly intervenes between it and the insertion of the tendon of the biceps. This ligament is rendered tense by supination of the radius.

157. Radio-carpal or wrist-joint.—This joint is formed by the lower end of the radius, which articulates with the scaphoid

and semilunar bones of the carpus: the lower end of the ulna is excluded from the joint by a triangular fibro-cartilage, which articulates with a small portion of the cuneiform bone. The joint is secured by an anterior, a posterior, and two lateral ligaments, forming, together, an uninterrupted capsule around it.

The *external lateral ligament* extends from the styloid process of the radius, to the outer side of the scaphoid bone. Some of its fibres are prolonged to the trapezium and the anterior annular ligament.

The *internal lateral ligament* proceeds from the extremity of the styloid process of the ulna, to the inner side of the cuneiform bone. Some of its fibres are attached to the pisiform bone.

The *anterior ligament* consists of two or more broad bands of ligamentous fibres, which arise from the front of the lower end of the radius, pass obliquely inwards, and are inserted into the front surfaces of the first row of carpal bones.

The *posterior ligament*, weaker than the preceding, arises from the posterior surface of the lower end of the radius, descends obliquely inwards, and is inserted into the posterior surfaces of the first row of the carpal bones.

Open the joint by a transverse incision across its posterior part. Observe that the lower surface of the radius, crusted with cartilage, forms, together with the fibro-cartilage at the end of the ulna, an arched excavation, with the broad diameter transverse, which receives the convex cartilaginous surfaces of the three first bones of the carpus. The cartilage of the radius presents a slight prominence from before backwards, dividing it into two surfaces, one of which corresponds to the scaphoid, the other to the semilunar bone. The fibro-cartilage at the lower end of the ulna corresponds to a small articular surface on the cuneiform bone.

The *synovial membrane* lines the triangular fibro-cartilage at the end of the ulna, is reflected over the several ligaments of the joint, and thence upon the first row of the carpal bones.

158. Joint between the lower ends of the radius and ulna.—The inner surface of the lower end of the radius presents a slight concavity, which rotates upon the convex circumference of

the lower end of the ulna : this mechanism is essential to the pronation and supination of the hand. These corresponding surfaces are crusted with a thin layer of cartilage, and are provided with a loose synovial membrane. The joint is strengthened in front and behind by a thin, loose, fibrous capsule, which extends from the anterior and posterior borders of the sigmoid cavity of the radius, to the anterior and posterior surfaces of the styloid process of the ulna. But the principal uniting medium between the bones is a strong fibro-cartilage.

Fibro-cartilage between the radius and ulna.—Saw through the bones of the fore-arm, and separate them by cutting through the interosseous membrane, and opening the synovial membrane of the joint between their lower ends. A good view will thus be obtained of the fibro-cartilage which connects them. It is triangular in form, and is placed transversely below the inferior extremity of the ulna, filling up the interval caused by the greater length of the radius. Its base is attached to the inner edge of the lower end of the radius, and its apex to the root of the styloid process of the ulna. It is thin at the base and the centre, thicker at the apex and the sides. Its upper surface is in contact with the ulna, and covered by the synovial membrane of the radio-ulnar joint; its lower surface forming a part of the wrist-joint, corresponds to the cuneiform bone. Its borders are connected with the anterior and posterior ligaments of the wrist. In some instances there is an aperture in the centre.

The *synovial membrane* of this joint is distinct from that of the wrist, except in the case of a perforation through the fibro-cartilage. One portion extends perpendicularly between the contiguous surfaces of the radius and ulna, the other horizontally between the head of the ulna and the upper surface of the fibro-cartilage. On account of its great looseness, necessary for the free rotation of the radius, it is often called the *membrana sacciformis.*

159. CONNEXION OF THE CARPAL BONES WITH EACH OTHER. —The bones of the carpus are arranged in two rows, an upper and a lower, adapted to each other, so as to form between them a joint, connected by anterior, posterior, internal, and external lateral ligaments.

The bones, constituting each row, are united by ligaments placed on their palmar and dorsal surfaces, and by others, placed between the bones, and hence called interosseous. Their contiguous surfaces (those of the pisiform and cuneiform excepted), are covered by the reflections of one synovial membrane.

The *upper row* is united by *transverse* ligaments proceeding from the scaphoid to the semilunar bone, and from the semilunar to the cuneiform, both on their dorsal and palmar surfaces: also, by *interosseous* ligaments, proceeding from the semilunar to the bones on either side of it.

The *pisiform bone* is articulated to the palmar surface of the cuneiform bone, to which it is united by a fibrous capsule. Inferiorly, it is attached by two strong ligaments, the one to the unciform bone, the other to the carpal end of the fifth metacarpal bone. This little articulation has, in the great majority of cases, a distinct synovial membrane: but, in some rare instances, it communicates with the radio-carpal joint.

The *lower row* of carpal bones is connected precisely in the same way as the upper. The dorsal and palmar ligaments pass transversely from one to the other. There are only two interosseous ligaments, one on either side of the os magnum; they are much thicker and stronger than those of the upper row, and unite the bones more firmly together.

160. Intercarpal joint.—The upper row of carpal bones is arranged in the form of an arch, so as to receive the corresponding convex surfaces of the os magnum and unciforme. Externally to the os magnum, the trapezium and trapezoid bones present a slightly concave surface, which articulates with the scaphoid. In this way a joint capable of flexion and extension is formed between the upper and lower row. It is secured by anterior, posterior, and two lateral ligaments, which are sufficiently loose to admit of the motion required. The anterior ligament consists of strong ligamentous fibres, which pass obliquely from the bones of the upper to those of the lower row. The posterior ligament consists of oblique and transverse fibres, which connect the dorsal surfaces of the bones of the upper with the lower row.

The lateral ligaments connect, externally, the scaphoid and trapezium ; internally, the cuneiform and unciform bones.

Divide the ligaments, in order to see the manner in which the carpal bones articulate with each other. Their surfaces are crusted with cartilage, and provided with a common *synovial membrane.* This membrane extends, superiorly, between the three bones of the upper row, so as to form two culs-de-sac ; inferiorly, it is prolonged into the joint between the carpal and the second and third metacarpal bones. In some cases it is continuous with the synovial membrane of the radio-carpal joint.

The joint between the upper and lower row of carpal bones admits of flexion and extension only ; but flexion is less limited than extension. The reverse is the case with regard to the radio-carpal joint.

161. Joint between the trapezium and the metacarpal bone of the thumb.—The trapezium presents a cartilaginous surface, convex in the transverse, and concave in the antero-posterior direction, (*i. e.* somewhat saddle-shaped,) which articulates with a cartilaginous surface on the metacarpal bone of the thumb, concave and convex in just the opposite directions. This peculiar adaptation of the two surfaces permits the several movements of the thumb, viz., flexion, extension, abduction, and adduction ; consequently circumduction. Thus we are enabled to oppose the thumb to all the fingers. The joint is surrounded by a fibrous capsule sufficiently loose to admit free motion, and stronger on the dorsal than on the palmar aspect. The security of the joint is also increased by the muscles which surround it, and by the insertion of the tendon of the extensor ossis metacarpi pollicis. It has a separate synovial membrane.

162. Connexion between the carpus and the metacarpal bones of the fingers.—The metacarpal bones of the fingers are connected to the second row of the carpal bones by ligaments upon their *palmar* and their *dorsal* surfaces.

The *dorsal* ligaments are the stronger. The metacarpal bone of the fore-finger has two : one from the trapezium, another from the trapezoid bone. That of the middle finger has also two, proceeding from the os magnum, and the os trapezoides. That of

the ring finger has also two, proceeding from the os magnum, and the unciform bone. That of the little finger has one only, from the unciform bone.

The *palmar* ligaments are arranged nearly upon the same plan. The metacarpal bone of the forefinger has one, from the trapezoid bone. That of the middle finger has three, proceeding from the trapezium, the os magnum, and the unciform bone. Those of the ring and little fingers have each one, from the unciform bone.

Besides the preceding ligaments, there is another of considerable strength, called the *interosseous.* It arises from the adjacent sides of the os magnum and the os unciforme, descends vertically, and is fixed into the ulnar side of the metacarpal bone of the middle finger. This ligament isolates the synovial membrane of the two inner metacarpal bones from the common synovial membrane of the carpus.

Separate the metacarpal bones from the carpus, by dividing the dorsal ligaments, and observe the relative form of their contiguous cartilaginous surfaces. The metacarpal bones of the fore and middle fingers are adapted to the carpus in such an angular manner as to be very slightly immoveable. The metacarpal bone of the ring finger, having a plane articular surface with the unciform bone, admits of more motion. But a still greater degree of motion is permitted between the unciform bone and the metacarpal bone of the little finger; the articular surfaces of each being slightly concave and convex in opposite directions. The greater freedom of motion of the metacarpal bone of the little finger is obviously essential to the expansion and contraction of the palm.

The *carpal extremities of the metacarpal bones of the fingers* are connected with each other by transverse ligaments, both on their dorsal and their palmar surfaces. They are also connected by interosseous ligaments, which extend between the bones, immediately below their contiguous cartilaginous surfaces.

The *digital extremities* of these bones are connected by the transverse metacarpal ligament (see 149, *a*).

The bones of the carpus and metacarpus should be separated from each other, in order to examine more thoroughly the form of their articular surfaces and their interosseous ligaments.

There are six distinct synovial membranes, proper to the lower end of the radius, and the several bones of the carpus:—

a. One between the lower end of the radius and the ulna.

b. One between the radius and the first row of carpal bones.

c. One between the trapezium and the metacarpal bone of the thumb.

d. One between the cuneiform and pisiform bones.

e. One between the first and second rows of carpal bones, (the intercarpal joint.)

This extends to the metacarpal bones of the fore and middle fingers.

f. One between the unciform bone and the metacarpal bones of the little and ring fingers.

163. Joints between the metacarpal bones and the phalanges of the fingers.—The first phalanx of the finger presents a shallow oval cavity, crusted with cartilage, with the broad diameter in the transverse direction, to articulate with the rounded cartilaginous head of the metacarpal bone, of which the articular surface is elongated in the antero-posterior direction, and of greater extent on its palmar than its dorsal aspect. This formation of parts permits flexion of the finger to a greater degree than extension; and also a slight lateral movement.

Each joint is provided with two strong *lateral,* and a *palmar* or *glenoid* ligament.

The *lateral* ligaments arise from the tubercles on either side of each metarcarpal bone, and inclining slightly forward, are inserted into the sides of the base of the first phalanx of the finger.

The *palmar* or *glenoid* ligament. This name is applied to a thick, compact, fibro-cartilaginous structure, which extends over the palmar surface of the joint. Inferiorly, it is firmly attached to the base of the first phalanx of the finger; superiorly, it is loosely adherent to the rough surface above the head of the metacarpäl bone. On either side it is inseparably connected with the lateral ligaments, so that with them it forms a strong capsule over the front and sides of the joint. Its superficial surface is slightly grooved, to receive the flexor tendons; its deep surface is adapted to cover the head of the metacarpal bone. Two sesamoid

bones are found in the glenoid ligament belonging to the joint between the metacarpal bone and the first phalanx of the thumb. These joints are secured on their dorsal aspect by the passage of the extensor tendon, and the expansion proceeding from it on either side. Their synovial membranes are loose, especially beneath the extensor tendons.

164. Joints between the phalanges of the fingers and the thumb.—The corresponding articular surfaces of the phalanges of the finger and thumb are so shaped as to form a hinge-joint, and, therefore, incapable of lateral movement. The ligaments connecting them are similar in every respect to those between the metacarpal bones and the first phalanges. The glenoid ligament of the last joint of the thumb generally contains a sesamoid bone.

END OF PART I.

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THE DISSECTION OF THE NECK.

An incision, not dividing more than the thickness of the skin, should be made down the middle of the neck from the lower jaw to the sternum; a second along the clavicle to the acromion; and a third along the base of the jaw as far back as the mastoid process of the temporal bone. Reflect the skin from the front and side of the neck, and a broad thin plane of muscular fibres, called the *Platysma myoides,* will be exposed. Between this and the skin there is a layer of adipose and cellular tissue, (sometimes called the superficial fascia), varying in thickness in different subjects, but generally more abundant at the upper part of the neck, especially in corpulent individuals, in whom it occasions the well-known appearance of a double chin.

1. The name *Platysma myoides* is given to a broad cutaneous muscle which covers the side of the neck. It arises by pale and scattered fibres in the subcutaneous tissue in front of the pectoralis major and deltoid muscles; thence proceeding upwards and inwards over the clavicle and along the side of the neck, the fibres become rather more closely aggregated, and terminate in the following manner:—The anterior cross those of the opposite platysma, immediately below the symphysis of the lower jaw, and are lost in the skin of the chin; those next in order, to which we would draw particular attention, are attached to the base of the jaw, to the extent of an inch, more or less; while the posterior ascend over the masseter muscle, and terminate partly in the subcutaneous tissue of the cheek, partly by mixing with the muscles at the corner of the mouth.

In the human subject the action of this muscle is very limited. We can best understand it by putting it in action in our own person. It is undoubtedly a muscle of expression. It can wrinkle the skin of the neck, as in the more violent passions, or co-operate with other muscles in giving a melancholy cast to the countenance

by drawing down the corner of the mouth. If the entire muscle be permanently contracted, it may occasion wry-neck, though it is true that distortion arising from such a cause is an exceedingly rare occurrence. A genuine case in point is related by Mr. Gooch,* in which a complete cure was effected, after the failure of all ordinary means of relief, by the division of the muscle a little below the jaw.

The Platysma myoides belongs to a class of muscles called cutaneous, from their office of moving the skin. In man they are not observed, except upon the neck and face, and there is a little one (palmaris brevis) in the palm of the hand. To understand their use thoroughly we must refer to the lower orders of animals, in whom they fulfil very important functions, not only by moving the skin itself, but also its appendages. For instance, by muscles of this kind the hedgehog, porcupine, and animals of that family can roll themselves up, and erect their quills: we are all familiar with the broad "panniculus carnosus" on the sides of herbivorous quadrupeds, which enables them to twitch their skins and thus rid themselves from the annoyance of insects. In birds, too, these muscles are extremely numerous, each feather having appropriate muscles to move it.

Divide the platysma across the middle of the neck, and reflect the upper and the lower portion.† Beneath it is exposed the general fibrous investment of the neck, called the *cervical fascia.* Upon this fascia are observed the superficial branches of the cervical plexus of nerves; the external jugular vein, crossing the sterno-cleido-mastoideus muscle, and a smaller vein in front called the anterior jugular. These superficial veins are subject to such varieties both in their size and their course, that a general description only is applicable. The following is their most frequent arrangement:—

2. *External jugular vein.*—This superficial venous trunk is observed crossing the sterno-mastoid muscle. It receives the

* Chirurg. Works.

† The more experienced anatomist, who may wish to dissect the minute ramifications of the cutaneous system of nerves, will do well to trace them through the transparent fibres of the Platysma, without reflecting it.

blood from several veins which correspond to branches of the external carotid artery, viz. the temporal, the internal maxillary, the transverse facial, the posterior auricular, and sometimes the occipital. All these veins unite in the substance of the parotid gland, and form a single trunk, which then crosses obliquely over the sterno-mastoid muscle, and descends near its posterior border towards the middle of the clavicle, where it perforates the cervical fascia and joins the subclavian.

In the neighbourhood of the angle of the jaw, the external jugular vein commonly communicates by a large branch with the internal jugular: and this is the anatomical reason of the practice of opening the former to relieve congestion of the brain. In its course down the neck it receives numerous small cutaneous veins, and previously to its termination is often joined by the supra-scapular and posterior scapular veins. It is provided with a valve near its middle, and another near its termination.

In opening the external jugular vein, the puncture should be made in the direction of the fibres of the sterno-mastoid muscle, because the fibres of the Platysma, being thus divided obliquely, will be less likely to contract over the orifice.

3. *Anterior jugular vein.*—This vein is situated more in the middle of the neck, and is much smaller than the external jugular. It commences by small ramifications below the chin, and descends along the front of the neck, nearly down to the sternum: it then curves outwards, beneath, but sometimes above, the sterno-mastoid muscle, and opens into the internal jugular, or perhaps the subclavian vein. We commonly meet with two anterior jugular veins, not always of equal size, one on either side, near the mesial line; immediately above the sternum they often communicate by a transverse branch.

The size of the anterior jugular vein is generally inversely proportionate to that of the external jugular. In cases where the latter is small, or where it terminates high up in the internal jugular, then the anterior jugular becomes an important supplemental cutaneous vein, and may attain very considerable size. It is not uncommon to find it a quarter of an inch in diameter, and in some instances we have seen it nearly half an inch. These

varieties should be remembered the more especially, considering the immediate proximity of the vein to the parts concerned in the operation of laryngotomy and tracheotomy.

4. *Superficial absorbent glands* are sometimes found near the larger cutaneous veins of the neck. They are of small size, and escape observation unless enlarged by disease. One or two are situated over the sterno-mastoid muscle; others about the mesial line. They receive the absorbents from the front and sides of the neck, and their efferent vessels are connected with the deep cervical glands.

5. *Superficial branches of the cervical plexus of nerves.*—We must now trace a number of cutaneous nerves which are observed ramifying beneath the platysma. They are the superficial branches of the cervical plexus, and their dissection requires considerable care, since they are imbedded in dense cellular tissue. The plexus itself from which they arise cannot now be seen: it is situated near the transverse processes of the upper cervical vertebræ, and is formed by the union of the anterior branches of the four upper cervical nerves. It lies upon the scalenus posticus and the levator anguli scapulæ muscles, and is covered by the posterior border of the sterno-mastoid. Its superficial branches, which we are now about to examine, emerge from behind the sterno-mastoid, and ramify in various directions. They may be divided into *ascending, descending,* and *transverse.*

a. The *ascending* branches, commonly two in number, are the auriculo-parotidean and the occipitalis minor.

The *auriculo-parotidean,* the larger of the two, is derived from the second and third cervical nerves, and ascends obliquely over the sterno-mastoid muscle, near the posterior border of the external jugular vein, towards the space between the angle of the jaw and the ear; in other words, towards the surface of the parotid gland. Near the gland it divides into two or more principal branches, of which the anterior is distributed to the integument of the gland and the side of the cheek; the posterior ascends to the cartilage of the ear, and ramifies chiefly upon its occipital surface. Other filaments communicate in the substance of the parotid gland with branches of the portio-dura, or facial nerve.

The *occipitalis minor* is derived from the second cervical nerve. It ascends near the posterior border of the sterno-mastoid muscle to the occiput, where it perforates the fascia and divides into filaments which supply the back of the scalp. Beneath the sterno-mastoid, this nerve commonly forms a loop which embraces the nervus accessorius, and sends a branch to it.

In some subjects we find a third ascending branch which runs close to the external jugular vein, and is distributed to the cartilage of the ear and the back of the scalp.

b. The *transverse* branch, sometimes called the *nervus superficialis colli,* passes forwards over the middle of the sterno-mastoid muscle towards the front of the neck, where it subdivides into several filaments which perforate the platysma and supply the skin. Some of the filaments ascend towards the ramus of the jaw, and communicate with the cervical division of the facial nerve; one or more turn downwards and accompany the anterior jugular vein.

c. The *descending,* sometimes called the supra-clavicular, branches, three or more in number, pass down the side of the neck, cross over the clavicle, and subdivide into numerous filaments which supply the integument of the front of the chest and the shoulder. One of these, called the *sternal* branch, crosses the lower part of the sterno-mastoid muscle, and supplies the integuments of the upper part of the sternum: some, called *clavicular,* pass over the middle of the clavicle, and are distributed to the integument of the pectoral muscle, the mammary gland, and the nipple; others, named *acromial,* cross over the outer end of the clavicle and supply the integument of the shoulder.

On reviewing the distribution of the cutaneous branches of the cervical plexus, we find that they supply the cartilage of the ear, the back of the scalp, the skin covering the parotid gland, also the skin on the front and side of the neck, the upper and front part of the chest and shoulder.

6. The *cervical branch of the facial nerve* will be found beneath the fascia near the angle of the jaw. It leaves the lower part of the parotid gland, perforates the cervical fascia, and divides into filaments which pass forwards forming arches a little below

the ramus of the jaw; some of these communicate with the transverse branch of the cervical plexus, others terminate in the platysma.

7. *Cervical fascia.*—Attention should in the next place be directed to the membranous investment, called the cervical fascia, which encloses the several parts of the neck. In some subjects this structure is so thin and cellular as to be scarcely discernible; in others, in which the muscles are well developed, it is proportionably dense and resisting. Under any circumstances it is relatively stronger in particular situations; as, for instance, in front of the trachea, in the fossa above the clavicle, and below the angle of the jaw. This fascia not only covers the soft parts of the neck collectively, but also, by its inflections, forms separate sheaths for the several muscles, vessels, and glands, isolating them, each one from the other, and maintaining them in their proper relative position. Hence it is obvious that a lengthened description of its numerous layers would be not only extremely tedious, but absolutely unintelligible, without a very considerable previous knowledge of the anatomy of the neck. It is sufficient for our present purpose to give merely a general outline of the attachment of the fascia; reserving for future attention its deeper layers as they successively come before us hereafter.

Commencing, then, at the upper part of the neck, we find that the fascia is firmly attached along the basis of the jaw, and especially to the angle, from which it extends backwards to the styloid process of the temporal bone, and thus forms what is commonly called the stylo-maxillary ligament. From the base of the jaw the fascia passes down, and is attached to the os-hyoides; it supports the soft parts which constitute the floor of the mouth, but furnishes no special sheath in this situation, excepting for the submaxillary gland.

Below the os-hyoides the fascia becomes rather more complicated, and for convenience of description may be divided into two layers, a superficial and a deep one, each of which we will trace from the mesial line.

The superficial layer descends from the os-hyoides, and is attached to the anterior border of the upper part of the sternum.

It occupies the interval between the sterno-mastoid muscles, divides on either side to form a sheath for each, and is continued backwards as a single layer to the spines of the cervical vertebræ. This same layer covers the supra-clavicular fossa, encloses the posterior portion of the omo-hyoid muscle, and is firmly connected to the clavicle.

The deep layer of the fascia, inseparably connected with the superficial on the front of the larynx, is attached to the posterior part of the sternum and the cartilage of the first rib; consequently there is, immediately above the sternum, an interval between the two layers of the fascia, which contains more or less fat and cellular tissue, and often one or two small absorbent glands. On either side the deep layer encloses the muscles in front of the larynx and trachea, and forms the sheath of the great vessels of the neck; from thence it is continued outwards beneath the clavicle, over the scalene muscles, the subclavian vessels and nerves, into the axilla.

Besides its more general purpose of forming sheaths for the several structures of the neck, there are one or two other points of view in which the cervical fascia should be regarded. It will be readily understood how the firm attachment of its layers to the sternum, the first rib, and the clavicle, forms a kind of fibrous barrier at the upper opening of the chest, which supports the softer parts of the neck, and prevents them from yielding to the pressure of the atmosphere during inspiration. Dr. Allan Burns* was the first to point out this important function of the cervical fascia, and has recorded a case exemplifying the effects which result from its destruction by disease.

Moreover, we shall subsequently find that the great veins at the root of the neck, namely, the internal jugular, subclavian, and innominate, are so closely united by means of the cervical fascia to the adjacent bones and muscles, that when divided they do not collapse, but gape. They become, as the French express it, "canalisées," and are in consequence in a better condition to resist the pressure of the atmosphere, which would tend to render them

* Surgical Anatomy of the Head and Neck.

flaccid and impervious during inspiration. But it must not be forgotten that this anatomical disposition of the great veins makes them more liable to permit the entrance of air when they are accidentally wounded in surgical operations. The danger of this occurrence is well known.*

A correct knowledge of the attachment of the chief layers of the cervical fascia is essential to a right understanding of the direction which pus may take when deposited in the cellular tissue of the neck. For instance, supposing the matter be seated external to the fascia, there is no ground for apprehension lest it should make its way into the chest. Supposing it be seated beneath the superficial layer, there is still no fear of its penetrating into the chest, but it may readily burrow beneath the clavicle into the axilla. On the other hand, when deposited in the loose cellular tissue by the side or at the back of the pharynx, matter may easily travel through the upper opening of the chest into the posterior mediastinum, and make its way into the trachea or œsophagus. *

8. *Sterno-cleido mastoideus.*—Remove the fascia from the surface of the sterno-cleido-mastoideus. This muscle, which forms the prominence on the side of the neck, arises by a flat tendon from the upper and front part of the sternum, and by fleshy and aponeurotic fibres from the sternal third, more or less, of the clavicle. The two portions of the muscle, separated at first by an interval containing cellular tissue, ascend, and remain distinct for some distance, the sternal fibres overlapping the clavicular: towards the upper part of the neck they become more closely united, and are inserted by a thick tendon into the anterior part and external surface of the mastoid process of the temporal bone, and by a broad aponeurosis into the outer half, more or less, of the superior semi-circular ridge of the occiput.

It will be observed that the sternal tendon is continued for some distance along the anterior border of the muscle, and that the tendon receives fleshy fibres on its under surface as low as the sternum. The extent of the clavicular origin varies; sometimes

* For some good observations on this subject, consult Velpeau, Lettre sur l'introduction de l'Air dans les Veines. Paris, 1838.

* Objects brought into view on raising Platysma My[oides]
External Jugular Vein
Anterior " "
Superficial branches of Cervical Plexus { Ascending, Descending & Transverse

it occupies the sternal half of the clavicle, nearly meeting the insertion of the trapezius; in such cases it would be necessary to divide this origin in the operation of tying the subclavian artery. The tendon inserted into the mastoid process may be seen by dissecting between the anterior border of the muscle and the parotid gland. Over its occipital insertion are commonly found one or two small absorbent glands which receive the absorbent vessels of the scalp.

The whole muscle is confined by its sheath in such a manner that it forms a slight curve with the convexity forwards. Its front border lies over the common carotid artery, and is the best guide to the vessel in the situation in which it is usually tied.

Action.—The sterno-mastoid, by drawing the mastoid process forwards, rotates the head and the ~~axis~~ atlas on the ~~atlas~~ axis, so as to turn the face obliquely towards the opposite side, giving a slight elevation to the chin. In this effect it co-operates with the opposite splenius. When the two sterno-mastoidei act together the head is bent forwards. This action is more particularly manifest in rising from the recumbent position.

The single action of the sterno-mastoid is well exemplified when it grows permanently rigid, and occasions what is called the wry-neck. When other means fail, the division of this muscle is sometimes recommended. In coming to a decision upon this question we should always be careful to inform ourselves of every circumstance—such, for instance, as the state of the other muscles—lest, after having cut through the sterno-mastoid, we should be disappointed in removing the deformity.

9. *Triangles of the neck.*—Anatomists avail themselves of the marked prominence which the sterno-mastoid muscle forms down the whole length of the neck, in order to divide this region into two great triangles, an anterior and a posterior. The base of the anterior triangle is formed by the ramus of the jaw, and its sides by the mesial line and the front border of the sterno-mastoid. The posterior has the clavicle for the base, while the sides are defined by the hind border of the sterno-mastoid, and the free border of the trapezius muscle.

A muscle called the omo-hyoid, which crosses the direction of the sterno-mastoid, subdivides these great primary triangles into four secondary smaller ones, of very unequal size: an anterior superior, an anterior inferior, a posterior superior, and a posterior inferior. It is unnecessary to particularize their several boundaries, since the direction of the homo-hyoid muscle renders them at once obvious. This conventional division of the neck into triangles, though not mathematically precise, is found convenient for the purpose of anatomical description.

Divide the sterno-mastoid transversely near the centre, and reflect the upper and the lower half from the subjacent sheath of fascia. It will probably be necessary to cut through one or two of its small nutrient arteries, which are derived either from the external carotid, or some one of its primary branches. Beneath the attachment of the lower half of the muscle there will be found a quantity of loose cellular tissue, with one or two small absorbent glands: the anterior jugular vein will probably be seen passing outwards to join the external, or perhaps the internal, jugular; and it is often accompanied by a small artery, a branch of the supra-scapular. The possibility of the vein or the artery being larger than usual should be borne in mind in the subcutaneous section of the sterno-mastoid. On this account it is recommended to divide the muscle about an inch from its origin.

12. The upper part of the sterno-mastoid muscle is traversed obliquely by a large nerve called the spinal accessory, "nervus accessorius Willisii."* This nerve, commonly classified as one of the divisions of the eighth pair of cerebral nerves, runs a very remarkable course. It arises from the cervical portion of the spinal cord by a series of filaments from the motor tract, the same tract which gives origin to the anterior roots of all the spinal nerves. Formed by the union of these filaments, the nerve ascends through the foramen magnum into the skull. It leaves the skull through the foramen lacerum posterius, and descends behind the internal jugular vein (in some cases in front of it) to the under surface of the sterno-mastoid muscle. The nerve passes obliquely through

* Willis, nervor. descr. cap. xxiii.; Opera Omnia, Amst. 1682.

the muscle, and crosses the posterior triangle of the neck to the trapezius, in which it terminates.

The nervus accessorius, in passing through the sterno-mastoid, gives filaments to it, some of which communicate with nerves derived from the cervical plexus; after leaving the muscle it is commonly joined by a branch from the second or the third cervical nerve.

A small artery, called the *mastoid,* arising from the external carotid, or from the occipital, accompanies the nervus accessorius into the mastoid muscle.

Having reflected the sterno-mastoid, a good view is obtained of the strong layer of fascia which lies beneath it, forming the under part of its sheath. This fascia is attached above to the angle of the jaw and the styloid process: thence it descends, expanding over and protecting the great vessels of the neck, and is firmly connected below to the clavicle and the first rib. It is this fascia which prevents matter from coming to the surface when suppuration takes place by the side of the pharynx. The fascia should be carefully detached from the muscles in front of the larynx and trachea, without disturbing their relative position.

11. *Depressor muscles of the os-hyoides and larynx.*—We must now examine a set of broad, ribband-like muscles, situated on the front of the neck, of which the office is to depress the os-hyoides and the larynx. They are well named, according to their respective attachments,—sterno-hyoid, sterno-thyroid, and omo-hyoid. It is more convenient to take the omo-hyoid first.

a. Omo-hyoideus.—This narrow slender muscle extends from the os-hyoides to the scapula, and crosses obliquely over the sheath of the common carotid artery and the internal jugular vein. It is digastric, that is to say, it consists of two fleshy portions, connected by an intermediate tendon. Its origin (not at present visible) takes place from the upper border of the scapula, close to the notch observable in that part of the bone, and also from a ligament which extends over the notch. The muscle comes forward across the lower part of the neck, passes beneath the sterno-mastoid, and then, changing its direction, ascends nearly vertically close to the outer border of the sterno-hyoid, and is inserted into the os-

hyoides about the junction of the body with the greater cornu. Thus it is observed that the muscle does not proceed straight from origin to insertion, but that it forms a very obtuse angle, or rather a curve beneath the sterno-mastoid. The intermediate tendon, before alluded to, is situated at the curve, and is connected by a strong layer or loop of fascia to the clavicle and the cartilage of the first rib; it is this connexion which chiefly maintains the muscle in its proper position.

In some subjects the omo-hyoid presents peculiarities; for instance, it may arise from the clavicle and ascend directly to the os-hyoides. Very rarely it is trigastric; that is, a third muscular slip ascends from the clavicle, or from the first rib to the intermediate tendon. Again, instead of being tendinous, it may be partly or entirely muscular at the curve. Sometimes it has a distinct insertion into the thyroid cartilage. Lastly, we have seen instances in which there was no trace of the muscle whatever.

b. Sterno-hyoid.—This is the most superficial of the muscles in front of the neck. It arises from the posterior surface of the first bone of the sternum, from the cartilage of the first rib, and sometimes from the clavicle. The fibres form a broad flat band, which ascends, gradually decreasing in breadth, and is inserted into the lower border of the body of the os-hyoides. Opposite the cricoid cartilage and the upper rings of the trachea, the sterno-hyoid muscles of opposite sides are in contact in the mesial line; below this situation they diverge from each other, leaving between them an interval, in which the sterno-thyroid muscles are exposed.

A *bursa mucosa* of considerable size is commonly found in the loose cellular tissue between this muscle and the thyro-hyoid membrane.

c. Sterno-thyroid.—This muscle is situated immediately beneath the sterno-hyoid. It has a broad origin from the posterior surface of the sternum, nearly opposite to the cartilage of the second rib. The muscle ascends, covering the front of the trachea and the lateral lobe of the thyroid gland, and gradually contracting, is inserted into the oblique ridge observable on the ala of the thyroid cartilage. It should be noticed that for some distance above the sternum the sterno-~~hyoid~~ thyroid muscles of opposite

sides are in contact in the mesial line; higher up, they slightly diverge to their insertions. In consequence of the arrangement of these and the preceding muscles the trachea is completely covered in front by muscular fibres.

The muscles last described frequently present at their lower part more or less marked transverse tendinous intersections. These intersections are in the human subject quite rudimentary; but in some animals with long necks they are very remarkable: in the giraffe, for instance, they are developed to such an extent that each depressor muscle is composed of alternations of muscle and tendon.

Action.—This group of muscles derives its nerves from a common source (the hypoglossal), and associates to produce a common result. Having their fixed point below, they will depress the os-hyoides and larynx. This movement is observed under two circumstances; in the return of the larynx to its proper position after having been raised in the act of deglutition, and in the utterance of grave sounds. That the larynx is elevated or depressed, according to the height of the note, may be easily ascertained by placing our finger upon it while we go through the gamut. Mr. Skey considers that the omo-hyoid is especially concerned in the act of sucking.*

12. *Thyro-hyoid.*—This muscle may be fairly regarded as a continuation of the sterno-thyroid upwards to the os-hyoides. It arises from the oblique line on the outer surface of the ala of the thyroid cartilage, and is inserted into the side of the body of the os-hyoides, and the anterior half of its greater cornu. It covers the thyroid cartilage and the thyro-hyoid membrane. *Action.*—It depresses the os-hyoides, or elevates the thyroid cartilage, according as its upper or lower attachment be the fixed point.

13. Thyroid body.—Divide, transversely, the sterno-hyoid and thyroid muscles about the centre, and partially reflect them, in order to expose what is called the thyroid body. This very vascular glandular-like substance is situated over the front and sides

* For the arguments upon which this opinion is based, see Med. Gaz. July 7th, 1848.

of the upper part of the trachea, and extends more or less upwards over the sides of the larynx. It consists of two lateral nearly symmetrical lobes, connected a little below the cricoid cartilage by a cross slip called the isthmus. Each lateral lobe is more or less conical in form, with the base opposite the sixth or seventh ring of the trachea, and the apex by the side of the thyroid cartilage. Its anterior convex surface is covered by the sterno-hyoid and thyroid muscles; its deep surface is concave, so as to be adapted to the sides of the trachea and larynx, and it usually extends so far backwards as to be in contact with the lower part of the pharynx. Its external border overlaps, in most cases only partially, but sometimes completely, the common carotid artery, particularly on the right side; and there are instances in which the lobe is deeply grooved by the vessel.

The isthmus or transverse portion connecting the two lateral halves is commonly situated over the 2d, 3d, and 4th rings of the trachea. This portion of the organ varies so much in its shape and dimensions that we rarely find it alike in two successive subjects. In some instances we have seen it entirely absent, so that there were two distinct thyroid bodies, one on either side of the trachea. This corresponds with the usual disposition in most of the lower orders of mammalia; but in man it is to be regarded as a failure in the union of the two halves by which the organ is originally developed. Generally speaking, the vertical measurement of the isthmus is about one inch. Between its upper border and the cricoid cartilage there is a space about four or five lines in extent, where the trachea is not covered by this vascular organ; and we would especially direct attention to this space as the more preferable situation for tracheotomy. But the vertical measurement of the transverse portion of the thyroid body is sometimes of very considerable length. We have seen it lying in front of the trachea almost down to the sternum. This circumstance deserves to be remembered, because, if the substance of the gland be injured in tracheotomy, a serious hemorrhage might be the result.

From the upper part of the isthmus, or from the adjacent border of either lobe, most commonly the left, a conical prolongation of

the thyroid body, called "the pyramid," frequently ascends in front of the crico-thyroid membrane, as high as the "pomum-Adami," and is connected to the body of the os-hyoides by fibrous tissue. In some subjects we may observe a few muscular fibres passing from the os-hyoides, or perhaps the thyroid cartilage, to the pyramid or some part of the thyroid body. This constitutes the "levator glandulæ thyroideæ,"* of some anatomists.† There are instances in which the pyramid is double; and lastly, we have seen a considerable portion of this thyroid substance lying over the crico-thyroid membrane, and completely isolated from the rest of the organ. These several varieties deserve the notice of the surgeon, because any one portion of this structure may become enlarged independent of the rest, and occasion a bronchocele.

Taken as a whole, the thyroid body varies considerably in size in different individuals and at different periods of life. It is relatively much larger in the child than the adult, and in the female than the male. In old age it diminishes in size, and presents a more indurated texture, in which earthy matter is occasionally found.

But by far the most notable consideration in respect to the organ in question is the number, the large size, and the free inosculations of its blood-vessels. In fact, it appears to be composed of a tissue of arteries and veins. The superior thyroid arteries enter the front surface of the apex of each lobe; the inferior thyroid enter the under surface of the base. A fifth artery, called a middle thyroid, is observed in some subjects; it comes from the arteria innominata, or the arch of the aorta, and ascends directly in front of the trachea to the isthmus.

Its veins are equally large, and form a plexus upon the surface. * The superior and inferior thyroid veins accompany their corresponding arteries, and open into the internal jugular. The middle thyroid descend over the front of the trachea beneath the sterno-thyroid muscles, communicate freely with each other, and terminate

* See preparation in Museum of St. Barth. Hosp. Patholog. Series, No. 14.

† Soemmerring de corp. hum. fabric.

* Quain states Vol 2 p 481. That the superior & <u>middle</u> thyroid veins end in the internal jugular & the <u>Inferior</u> end on the right side in the superior Cava, & on the left in the left brachio-cephalic

in the left vena innominata. The size of these latter veins, and the possible existence of a middle thyroid artery, should be borne in mind in the performance of tracheotomy.

Its nerves are furnished by the laryngeal branch of the pneumogastric and the cervical ganglia of the sympathetic. They are of small size, and accompany the arteries.

Structure.—The thyroid body is invested by a very thin covering of condensed cellular tissue, which penetrates into its interior, and divides it into more or less distinct lobes. The interior of the organ consists of a multitude of vesicles which do not communicate with each other, and vary considerably in size. Some of them may be recognised with the naked eye; but the greater number require the aid of the microscope. In hypertrophy of the gland we sometimes see here and there one as large as a horse-bean, or even larger. They contain a glairy transparent fluid, full of nucleated cells. The ultimate branches of the arteries ramify most minutely upon their walls. Of its function nothing is with certainty known.

A particular part of the under surface of the organ is closely connected by fibrous tissue to the first rings of the trachea and the cricoid cartilage. We may easily be satisfied of this by dividing the isthmus and turning back one half of it. This connexion is deserving of notice, because it explains the reason why the thyroid body accompanies the larynx in the movement of deglutition.

If, now, the relations of the different lobes of the thyroid body to the trachea and œsophagus be properly understood, there can be no difficulty in predicating the consequences which may result from their enlargement. Of course, the nature and severity of the symptoms will be, to a certain extent, determined by the particular part of the organ affected. For instance, if the isthmus be the seat of disease, difficulty in breathing will probably be the most prominent symptom; and an enlargement of the left lobe is more likely to produce a difficulty in swallowing, on account of the greater inclination of the œsophagus towards the left side.

An instance is related by Allan Burns in which the isthmus connecting the two lateral lobes was placed between the trachea and

the œsophagus. It must be obvious that enlargement of a part so situated would occasion most fearful symptoms. We have seen two cases in which the lateral lobes projected so far inwards that they completely embraced the back of the œsophagus.

Small absorbent glands are generally observed about the thyroid body, especially in front of the trachea, near the isthmus; and one or more are situated over the crico-thyroid membrane. These glands, if enlarged by disease, might on superficial examination be mistaken for a small bronchocele.

13. *Deep cervical absorbent glands.*—In the loose cellular tissue which surrounds the great vessels of the neck, we meet with a series of absorbent glands, called the deep cervical, or glandulæ concatenatæ. They form an uninterrupted chain from the base of the skull, along the side of the neck, to the clavicle, beneath which they are continuous with the thoracic and the axillary glands. It is important to notice that some of these glands lie anterior to the common carotid artery, while others are interposed between it and the spine. This natural disposition explains the well-known fact, that, when these glands are enlarged, the great vessels and nerves of the neck are liable to become imbedded in their substance.

The glands are particularly numerous near the division of the common carotid, by the side of the pharynx, and the posterior portion of the digastric muscle. The absorbent vessels connected with them arrive from all parts of the head and neck. These vessels eventually unite, so as to form, on both sides of the neck, one or more large absorbent trunks, which may be called the jugular. On the left side this trunk joins the thoracic duct, or opens by a separate orifice into the left subclavian vein. On the right, it joins the right thoracic trunk, or terminates separately in the veins.

The contiguity of the glands to the great vessels and nerves of the neck explains the nature of the symptoms produced by their enlargement. The tumor may be so situated as to be alternately raised and depressed by the pulsation of the carotid, and thus simulate an aneurism. A careful examination, however, will generally detect the difference between a real and an apparent pulsation. By grasping the tumor we soon become sensible that the rising and falling does not depend upon any variation of its magnitude, but

upon the impulse derived from the artery; consequently, if we lift the tumor, as it were, from the sphere of action of the vessel, all feeling of pulsation ceases.

14. Course and relations of the common carotid artery.—Having proceeded thus far in the dissection, our next object should be to examine the course of the great artery of the head and neck, and its immediate relations to the surrounding parts. It will be necessary to remove with care the absorbent glands which lie upon the sheath of the vessels; and in doing so, we may observe how freely these glands are supplied with arteries.

The common carotid arteries of opposite sides differ in respect to their origin. The right arises from the arteria innominata, nearly behind the corresponding sterno-clavicular joint; the left springs directly from the arch of the aorta, and lies, therefore, at its origin deeper in the chest. Their course in the neck, with which we are at present concerned, is so far alike on both sides that one description will suffice.

The common carotid artery ascends obliquely upwards and outwards, close to the spine, by the side of the trachea and larynx, as high as the upper border of the thyroid cartilage (higher or lower in some instances), and then divides into the external and the internal carotid. Its direction nearly corresponds with a line drawn from the sternal end of the clavicle to a point midway between the angle of the jaw and the mastoid process of the temporal bone; therefore the arteries of opposite sides diverge from each somewhat like the branches of the letter V. Parallel with the outer side of the artery runs the great internal jugular vein, which if distended with blood is often so large as partially to overlap and conceal the artery. By gently separating the artery from the vein, we shall find a large nerve, the pneumo-gastric, which descends on a deeper plane between them; all three are enclosed in a common sheath of fascia, but are separated from each other by delicate septa. Crossing obliquely from without inwards, over the front of the sheath may be observed a nerve called "nervus descendens noni" (a branch of the hypoglossal or ninth nerve), which passes down to supply the depressor muscles of the os-hyoides and larynx. Between the sheath and the vertebral column there is the sympathetic nerve.

It is manifest that, at the lower part of the neck, the carotid artery is deeply seated, that it must be covered by the sternal portion of the sterno-mastoid muscle, the sterno-hyoid and thyroid muscles, the inferior thyroid veins, and of course by a strong layer of fascia: about three inches, more or less, above the sternum it is crossed by the slender omo-hyoid muscle. But in consequence of the divergence of the sterno-mastoid and omo-hyoid muscles, the artery in the upper part of its course becomes more superficial, and is covered only by the platysma, the cervical fascia, and some large veins which cross it to join the internal jugular. It is clear that a ligature can be more easily placed round the artery in this situation than elsewhere, and that an incision along the inner border of the sterno-mastoid is the surest way of exposing it. Here also the vessel might be compressed for a short time against the vertebræ.

Along the vertebral column the artery lies successively upon the longus colli and the rectus capitis anticus major muscles. Near the lower border of the sixth cervical vertebra, the inferior thyroid artery crosses behind the carotid, on its course to the base of the thyroid gland.

Towards the mesial line, the carotid artery is in relation with the œsophagus and recurrent nerve, the trachea, and the larynx. The lateral lobe of the thyroid gland overlaps the artery, more or less in different instances, particularly on the right side.

If, now, we compare the carotid arteries at the lower part of the neck, it will be observed that the right is situated more in front of the trachea than the left, which is placed in more immediate contact with the œsophagus, in consequence of the inclination of the œsophagus towards the left side. This difference is especially marked in cases where the arteria innominata ascends higher and more in front of the trachea than usual. We have seen repeated instances in which the right carotid was situated so directly in front of the trachea that unless great care were taken it would inevitably have been wounded in the performance of the lower operation of tracheotomy.

The common carotid, at its point of division, generally dilates so as to form a small bulb. This dilatation is in some instances so

considerable that during life it might have occasioned the suspicion of an incipient aneurism.

Division of the common carotid.—It is necessary to be aware that the situation of the division of the common carotid is liable to great variety. Most commonly, as before stated, it occurs at the upper border of the thyroid cartilage. Its bifurcation, however, may take place at any point between the level of the os-hyoides and the lower border of the cricoid cartilage. Instances have been observed in which the bifurcation has occurred above or even below the points specified; but such anomalies are exceedingly rare. In early life the division takes place farther from the angle of the jaw than in the adult, in consequence of the non-development of that part of the bone.

15. *Internal jugular vein.*—This great vein descends along the outer side of the common carotid artery. It is one of the chief venous trunks which return the blood from the brain. From the "foramen jugulare," at the base of the skull, the vein passes down, lying to the outer side of the internal carotid: we now see it continuing its course along the outer side of the common carotid, and by tracing it downwards we shall find that it joins the corresponding subclavian at nearly a right angle, to form the vena innominata.

About the level of the os-hyoides and the upper part of the larynx the internal jugular vein commonly receives the facial, lingual, pharyngeal, and superior thyroid veins. It is important to notice that these tributary veins cross both the carotid arteries, and form a kind of plexus in front of them. At the lower part of the neck it is joined most commonly by the inferior thyroid vein.

Previously to its termination, the internal jugular vein advances slightly to meet the subclavian, so that it lies on a plane a little anterior to the carotid artery. Again, since the course of the vein is perpendicular, while that of the artery is more oblique, there will necessarily be a small interval between them at the root of the neck, more especially on the right side. In this interval is situated the pneumogastric nerve, and still deeper the vertebral artery. Here also on the left side we shall find the thoracic duct.

Generally speaking, the internal jugular vein is completely

covered by the sterno-mastoid muscle. In subjects, however, where the clavicular origin of the muscle is narrow, the vein may project beyond its outer edge. We can easily understand how manifest a venous pulsation might be under such circumstances, if there should be any imperfection in the auriculo-ventricular valve.

16. *Nervus descendens noni.*—The nerve which descends in front of the sheath of the common carotid artery is the descending branch of the hypoglossal or ninth cerebral nerve. By tracing this branch upwards, we shall find that it leaves the hypoglossal immediately before this nerve makes its curve forwards round the occipital, or perhaps the mastoid artery. At first the descendens noni lies within the sheath between the internal carotid artery and the jugular vein; opposite the os-hyoides, or nearly so, it perforates the sheath and crosses obliquely over the common carotid from the outer towards the inner side. About two or three inches above the clavicle the descendens noni is joined by one or more branches (communicantes noni) which come from the second and third cervical nerves. These communicating branches descend on the outer side of the internal jugular vein, and form by their junction with the descendens noni two or more loops in front of the sheath of the carotid. From these loops nerves pass off to supply the depressors of the os-hyoides and larynx; that is to say, the sterno-hyoid, sterno-thyroid, and omo-hyoid muscles: to each of the two portions of the latter there is a separate filament.

In some subjects the descendens noni lies completely concealed within the carotid sheath; the loop-like communications with the cervical plexus will then be found behind the internal jugular vein.

One of its filaments may sometimes be traced into the chest, where it joins either the cardiac plexus, or the phrenic nerve.

Instances have been observed in which the descendens noni is joined by a large branch from the pneumogastric.

ANATOMY OF THE SUBMAXILLARY REGION.

17. Remove the fascia from its attachment to the ramus of the jaw in order to examine the subjacent parts. The first most con-

spicuous object is the submaxillary gland. Observe that the fascia forms for it a complete case, to which it is simply connected by cellular tissue. Beneath the ramus of the jaw, we find, embedded in cellular tissue and fat, several absorbent glands, of which some lie superficial to the salivary gland, others beneath it. These glands receive the superficial absorbents of the face, the tonsils, the tongue, and the salivary glands themselves.

A little dissection will expose a muscle called the digastricus, from its consisting of two distinct portions connected by an intermediate tendon. These two portions form, with the ramus of the jaw, a triangular space, of which we now propose to examine the contents. And first of the digastric muscle itself.

19. *Digastricus.*—This muscle consists of an anterior and a posterior portion united by a tendon which is connected by fascia to the os-hyoides. The posterior portion, the longer of the two, arises from a deep groove on the inner side of the mastoid process of the temporal bone. It descends forwards behind the angle of the jaw, and terminates upon a tendon, which, after sending an aponeurosis to the os-hyoides, turns upwards at an obtuse angle and gives attachment to the fibres of the anterior portion; this ascends towards the mesial line, and is fixed to the under surface of the symphysis of the jaw.

Raise the submaxillary gland to see the tendon of the digastricus, and the manner in which it is fastened by aponeurosis to the body and greater cornu of the os-hyoides; observe also that this aponeurosis is connected in the mesial line with its fellow of the opposite side, so that a strong fibrous expansion occupies the interval between the anterior portions of the digastrici.

Action.—When both portions of the digastric muscle contract, it is clear that the direction of the power will be in the diagonal of the two forces; consequently the os-hyoides will be raised. Hence it is an important muscle concerned in the act of deglutition. Of course the jaw must be fixed, for we cannot swallow without first shutting the mouth. Supposing the os-hyoides to be the fixed point, then the anterior portion will act as a depressor of the lower jaw,

19. *Stylo-hyoideus.*—This is a thin slender muscle which ac-

companies the posterior portion of the digastricus. It arises by a flat tendon from the outer surface of the styloid process of the temporal bone. The muscular fibres generally divide, so as to embrace the tendon of the digastricus, and, reuniting, are inserted into the upper part of the body of the os-hyoides near the greater cornu. Its *action* is to raise and draw back the os-hyoides.

The posterior portion of the digastricus and the stylo-hyoideus derive their nerves from the facial, or portio dura; whereas the anterior portion of the digastricus is supplied by the mylo-hyoidean nerve, a branch of the third division of the fifth pair.

20. *Submaxillary salivary gland.*—This gland is situated between the two portions of the digastricus. In the ordinary position of the head it is partially concealed by the ramus of the jaw, but when the head falls back the gland is necessarily more exposed. It is about the size of a large chestnut, and is divided by deep fissures into several lobes. Its upper margin, thick and convex, is covered by the ramus of the jaw; its lower margin is thinner, and overlaps the side of the os-hyoides. Its cutaneous surface is smooth and flat, but the lobes on its deep surface are more irregular, and are often continuous with those of the sublingual gland. By raising the gland we find that it lies upon the mylo-hyoideus, the hyo-glossus, and the tendon of the digastric muscle, and a small portion of the hypoglossal nerve, which is seen above the tendon.

The duct of the gland (named after its discoverer Wharton's duct*) passes off from its under surface round the border of the mylo-hyoideus, and then running forwards above that muscle, opens into the mouth in the centre of a papilla by the side of the frænum linguæ. In length it is about two inches; but it is not of equal dimensions throughout, being considerably dilated about the middle, and very much contracted at the orifice. We sometimes observe in our own person that saliva, collected in the dilated portion of the duct, is spirted to a considerable distance

* Thom. Wharton, Adenographia, seu glandularum totius corporis descriptio. 12mo. Amstel. 1659.

out of the narrow orifice, in consequence of the sudden contraction of the neighbouring muscles.

The facial artery is seen passing either through the substance of the gland, or along a groove on its under surface; and it supplies the gland very freely with small branches. The facial vein usually runs over the cutaneous surface of the gland and joins the internal jugular.

21. *Sub-mental artery.*—The name of this artery implies where it will be found. It comes from the facial immediately below the jaw, and runs horizontally forwards, under cover of the basis of the jaw, to the symphysis, where it turns upwards over the chin, and inosculates with the terminal branches of the inferior dental artery. The sub-mental supplies the submaxillary absorbent glands, the mylo-hyoid, and the anterior portion of the digastricus. This artery, commonly of small size, is in some subjects very much larger than usual, and after pursuing its ordinary course for some distance, perforates the mylo-hyoid near the symphysis of the jaw, to supply the sublingual gland and the tongue. We have seen serious hæmorrhage from such an artery, wounded in opening an abscess.

a. Mylo-hyoidean nerve.—Near the sub-mental artery we find a small nerve which supplies the mylo-hyoideus muscle and the anterior portion of the digastricus. It proceeds from the inferior dental nerve, just before its entrance into the dental foramen, runs in a groove observable on the inner side of the ramus of the jaw, and then comes forward between the bone and the internal pterygoid muscle to the outer surface of the mylo-hyoid, where it is now seen.

Though apparently arising from the inferior dental, this nerve is, properly speaking, derived from the motor root of the fifth pair.

In some instances it sends a branch which perforates the mylo-hyoid muscle, and joins the gustatory nerve.

We have now an opportunity of observing what is called the *stylo-maxillary ligament.* It is commonly described as a reflection of the cervical fascia, from the angle of the jaw to the styloid

process of the temporal bone. But this falls short of giving an adequate idea of its extent. Correctly speaking, it is a broad sheet of fascia which is attached to the angle of the jaw, and thence penetrates deeply inwards to be connected with the styloid process, the stylo-hyoid ligament, and the pharyngeal fascia. It forms a kind of barrier which stops the finger from passing behind the angle of the jaw to the tonsils and the back of the pharynx; and it is this fascia which prevents any accumulation of matter formed in the neighbourhood of the tonsils from making its way to the surface. It may be as well to mention that this so-called stylo-maxillary ligament intervenes between the submaxillary and the parotid glands. But not always so: in some subjects the two glands are directly connected.

Reflect the anterior portion of the digastricus from its insertion into the jaw; observe the branch of the mylo-hyoidean nerve which enters it in company with a branch of the sub-mental artery. Turn outwards the submaxillary gland. We have next to examine a muscle beneath it, called the mylo-hyoideus.

22. *Mylo-hyoideus.*—This muscle has a tendinous origin from a ridge on the inner surface of the lower jaw, extending from just below the last molar tooth obliquely downwards to within a short distance of the symphysis. The fibres successively increasing in length from before backwards, pass inwards towards the mesial line, and unite with the muscle of the opposite side by means of a delicate tendinous raphé; but the posterior fibres are inserted into the body of the os-hyoides. Thus the muscles of opposite sides form by their union a muscular floor for the cavity of the mouth. In some cases the anterior fibres of the muscle are absent, and the sublingual gland is in consequence more or less exposed.

Action.—The two muscles of opposite sides conjointly elevate the os-hyoides and the floor of the mouth; as, for instance, in the act of deglutition.

Reflect the mylo-hyoideus from the mesial line and the os-hyoides, and turn it over the ramus of the jaw: we shall thus expose the following parts. In the mesial line the genio-hyoideus extends from the symphysis of the jaw to the body of the os-hyoides; laterally, the hyo-glossus, a square flat muscle, ascends

perpendicularly from the side of the os-hyoides to the side of the tongue. Between the two last-mentioned muscles there is an interval, in which is observed part of the genio-hyo-glossus lying upon a deeper plane. Upon the hyo-glossus muscle we find the hypoglossal and gustatory nerves, the duct of the submaxillary gland, the sublingual gland, and two or three small absorbent glands. These several objects should now be individually examined.

23. *Genio-hyoideus.*—This muscle is situated in the mesial line parallel to its fellow of the opposite side. It arises from a tubercle observable on the inner surface of the symphysis of the jaw, and is inserted into the middle of the upper part of the body of the os-hyoides. Its *action* is to draw the os-hyoides upwards and forwards.

24. *Hyo-glossus.*—This muscle arises from a part of the body and nearly the whole of the greater cornu of the os-hyoides. Ascending perpendicularly, it forms a broad flat plane of muscular fibres, which expand upon the posterior two-thirds of the side of the tongue.

Action.—Singly it draws one side of the tongue towards the floor of the mouth; conjointly with its fellow it draws down the tongue towards the os-hyoides.

25. *Genio-hyo-glossus.*—By reflecting the genio-hyoid from its attachment to the jaw, the genio-hyo-glossus will be in part exposed; but we shall have a more complete view of it at a future stage of the dissection. It consists of a thick plane of muscular fibres placed vertically in the mesial line in contact with its fellow. It arises by a tendon from the tubercle on the inner surface of the symphysis of the jaw. From this tendon the fleshy fibres radiate to the os-hyoides and the under surface of the tongue. The upper fibres, which are close to the mucous membrane of the mouth, arch upwards and forwards to the tip of the tongue; the lower ones, in contact with the genio-hyoideus, descend and are attached to the body of the os-hyoides; the intermediate fibres radiate backwards and terminate in the substance of the under surface of the tongue. Thus the shape of the entire muscle may be compared to a fan, with the apex at the symphysis of the jaw. *Action.*—The pos-

terior and inferior fibres, by elevating the os-hyoides and drawing forwards the base of the tongue, can protrude the tongue from the mouth: the anterior fibres can retract the tongue when protruded. It is one of the chief muscles concerned in suction.

26. The *Hypoglossal* or *ninth cerebral nerve,* now seen crossing the hyo-glossus muscle, is the great motor nerve of the muscles of the tongue. It arises by several roots from the front surface of the medulla oblongata, leaves the skull through the anterior condyloid foramen of the occipital bone, and descends very obliquely between the internal carotid artery and the internal jugular vein. A little below the posterior portion of the digastricus, the nerve makes a curve forwards over both carotid arteries; it then crosses the hyo-glossus near the greater cornu of the os-hyoides, and at the anterior border of the muscle divides into branches, of which some supply this muscle and the genio-hyoideus, but the greater number terminate in the genio-hyo-glossus muscle.

Near the point where the hypo-glossal nerve curves round the occipital artery, it gives off its descending branch to the depressor muscles of the os-hyoides (see § 16). Near the apex of the cornu of the os-hyoides it sends a small branch to the thyro-hyoid muscle. Lastly, several filaments from it ascend upon the hyo-glossus muscle and communicate with the gustatory nerve.

27. *Sublingual salivary gland.*—This gland is situated along the inner side of the ramus of the jaw immediately beneath the mucous membrane of the floor of the mouth, into which it slightly projects, so that it can be readily felt by the finger. In shape it is somewhat oblong, with the long axis, about 1½ inch in length, directed from before backwards. Inferiorly it rests upon the upper surface of the mylo-hyoid muscle, and towards the mesial line it is in contact with the hyo-glossus and the genio-hyo-glossus. Its several lobes are loosely connected together by areolar tissue, and the more posterior are often closely united with those of the sub-maxillary gland.

The ducts of the sublingual gland (named after their discoverer the ducts of Rivinus*) are extremely thin and delicate, and vary

* Aug. Quirin. Rivinus, de Dyspepsia. Lips. 1678.

in number from seven to twelve. They terminate by minute openings behind the papilla of the submaxillary duct, along a ridge observable upon the mucous membrane of the floor of the mouth. They range from one-eighth to one-third of an inch in length. The ducts of those lobes in the immediate neighbourhood of Wharton's duct terminate in it.

In some instances the sublingual glands are connected with each other in the mesial line.

The duct of the submaxillary gland may now be seen crossing the gustatory nerve, and passing under the sublingual gland to the floor of the mouth.

28. *Gustatory nerve.*—This nerve will be found on the inner side of the sublingual gland. It is a branch of the inferior maxillary, or the third division of the fifth pair. It descends between the ramus of the jaw and the internal pterygoid muscle, and comes forwards along the upper part of the hyo-glossus, crossing at an acute angle over the Whartonian duct. Having reached the under part of the tongue, the nerve divides into numerous filaments which traverse the substance of this organ and supply the mucous membrane covering its anterior three-fourths.

It has been already stated that the gustatory and hypo-glossal nerves are connected by filaments upon the surface of the hyo-glossus muscle.

a. Submaxillary ganglion.—By carefully examining the gustatory nerve before it crosses the Whartonian duct, we shall find close to its lower border a small ganglion about the size of a pin's head, and rather flattened in appearance. Like the other ganglia of this kind, in connection with the branches of the fifth pair, (nervus trigeminus) we find that it receives nerve-filaments of three different kinds, viz. motor, sensitive, and sympathetic. Its motor root is represented by the corda-tympani, which, though apparently a branch of the gustatory, is in point of fact derived from the facial (a nerve of motion) during its course through the tympanum of the ear. Its sensitive roots proceed from the gustatory; and its connexion with the sympathetic system of nerves is established by a branch which comes from the nervi molles encircling the facial artery. Thus provided with nerves from these several sources the

ganglion gives off numerous slender filaments which supply the submaxillary and sublingual glands, and their ducts.

Two or three small absorbent glands may in some subjects be observed near the sublingual gland, not far from the mucous membrane of the mouth. They receive some of the absorbents from the tongue.

Having advanced thus far in the dissection, the next object of attention should be the course and relations of the external carotid artery and its branches in the neck. In preparing a view of these vessels more or less difficulty will be experienced on account of the veins, nearly all of which are situated superficially with regard to their corresponding arteries.

29. Course and relations of the external carotid artery.—The external carotid artery arises from the inner side of the common carotid, most frequently about the level of the upper border of the thyroid cartilage. It ascends with a slight inclination backwards to the interval between the mastoid process and the angle of the jaw, where it enters the parotid gland, and finally terminates near the neck of the jaw, by dividing into the temporal and internal maxillary arteries.

In the first part of its course it is situated between the front border of the sterno-mastoid and the side of the pharynx; here it is comparatively superficial, being covered only by the platysma, the cervical fascia, and some large veins, probably the facial, the lingual, and perhaps the superior thyroid. A little above the cornu of the os-hyoides it is crossed by the hypoglossal nerve, and still higher up by the posterior portion of the digastricus and the stylo-hyoideus muscle. In the remainder of its course it is deeply embedded in the substance of the parotid gland.

It is important to notice the relative position which the external and internal carotid arteries hold with regard to each other. For a short distance after their origin they lie nearly on the same plane, the external being nearer to the mesial line; but as it ascends backwards towards the angle of the jaw the external carotid must necessarily cross obliquely in front of the internal, which runs almost perpendicularly by the side of the pharynx to the base of the skull, and we shall subsequently find that certain parts intervene

between them; namely, the stylo-glossus and the stylo-pharyngeus muscle, the stylo-hyoid ligament, and the glosso-pharyngeal nerve.

The external carotid is accompanied by small veins which form a plexus around it.

From the view now obtained of the relations of the external carotid it is obvious that a ligature could be placed around it with greater facility in the first than in any other part of its course. The line of the external incision should correspond with the front border of the sterno-mastoid. Nothing more would be necessary than to divide the platysma and the cervical fascia; but after all, the chief obstacle would be caused by the confluence on the front of the artery of the facial, lingual, and other large veins, which in all probability would be distended with blood. Of course due care should be taken not to include in the ligature the superior laryngeal nerve which crosses obliquely underneath the artery.

30. *Branches of the external carotid.*—Exclusive of the temporal and the internal maxillary, its two terminal arteries, the carotid commonly gives origin to six separate branches; of these, three, namely the superior thyroid, the facial, and the lingual, run forwards; two, the occipital and the posterior auricular, proceed backwards; and one, the ascending pharyngeal, runs upwards by the side of the pharynx. They commonly arise in the order in which they will be here described.

31. *Superior thyroid artery.*—This is usually the first branch of the external carotid. It arises from its inner side a little below the greater cornu of the os-hyoides, forms a slight curve with the convexity upwards, and then descends beneath the omo-hyoid, sterno-hyoid, and sterno-thyroid muscles, to the upper and front surface of the lateral lobe of the thyroid body, in which its branches are principally distributed, inosculating freely with the inferior thyroid. Superficial in the first part of its course, it is afterwards more deeply seated. But we would especially call attention to the passage of the artery over the upper and front part of the lobe of the thyroid body, because its pulsation is of material service in distinguishing a bronchocele from other tumors.

The branches of this artery are as follows:—

a. The *hyoid,* a small muscular branch sometimes absent, runs horizontally inwards below the greater cornu of the os-hyoides.

b. The *superior laryngeal* branch passes inwards, accompanied by the superior laryngeal nerve, beneath the thyro-hyoid muscle, perforates the middle of the thyro-hyoid membrane, or sometimes the thyroid cartilage, and supplies the muscles and the mucous membrane of the larynx.

c. The *sterno-mastoid,* a small branch variable as to origin and size, scarcely deserves notice except that it descends over the sheath of the carotid artery to the mastoid muscle.

d. The *crico-thyroid,* an artery apparently insignificant, but of great interest in reference to the operation of laryngotomy, crosses the crico-thyroid ligament, and communicates with a corresponding branch to the opposite side. One or two small branches pass through the ligament to the interior of the larynx. It is important to be aware that the crico-thyoid artery is subject to variety both in point of direction and size. In the generality of cases it is small, and runs transversely across the centre of the ligament; we should therefore be least likely to wound it, in laryngotomy, by dividing the ligament close to the cricoid cartilage. It is, however, by no means infrequent to find this artery a branch of considerable size, taking an oblique or a perpendicular direction in front of the ligament, and finally distributed to one of the lobes of the thyroid body. We have even seen several instances in which the ligament was crossed by the main trunk of the superior thyroid. These facts should establish the practical rule in laryngotomy not to make an opening into the larynx until we have fairly exposed the crico-thyroid ligament, and ascertained whether any unusual variety exist either in the size or the direction of its artery.

Among the many arterial inosculations about the thyroid body, there are commonly two which deserve notice; the one is formed between the two superior thyroid arteries along the upper border of the isthmus, the other takes place along the outer part of the lateral lobe between the superior and inferior thyroid. These inosculations are deserving of notice the more, because they militate against the practice of tying one of the thyroid arteries in order to cure or relieve a bronchocele.

The *superior thyroid vein* generally empties itself into the internal jugular; and it should be remembered that it crosses in some cases over the common carotid, in others over both external and internal carotid arteries.

32. *Superior laryngeal nerve*.—This nerve will be found a little above the superior laryngeal artery. Arising from the ganglion of the nervus vagus, it descends behind both carotid arteries, and comes forwards between the os-hyoides and the thyroid cartilage. It perforates the thyro-hyoid membrane in company with its corresponding artery, and is distributed to the mucous membrane of the larynx. It communicates with the recurrent laryngeal by one or more filaments.

a. Before it enters the larynx the superior laryngeal nerve gives off a slender branch called the *external laryngeal*, which supplies the crico-thyroid muscle, and may sometimes be traced into the inferior constrictor of the pharynx. It usually accompanies either the trunk, or one of the chief branches of the superior thyroid artery.

33. *Lingual artery*.—This is commonly the second branch of the external carotid. Curving slightly upwards from its origin, it soon proceeds horizontally forwards beneath the hyo-glossus muscle, parallel to the upper edge of the cornu of the os-hyoides; near the anterior border of the hyo-glossus the artery ascends nearly perpendicularly to the under surface of the tongue, beneath which it runs tortuously forwards to the apex under the name ~~nerve~~ of the ranine. The curves made by the artery, and its tortuosity under the tongue, are obviously for the purpose of allowing the unrestricted elongation of this organ. In the first part of its course it is comparatively superficial; in the middle it is deeply placed between the hyo-glossus and the middle constrictor of the pharynx; in the last part—that is, beneath the tongue—it is situated between the lingualis and the genio-hyo-glossus.

The relative position of the lingual artery and nerve is as follows. Near the apex of the cornu of the os-hyoides the nerve lies nearly parallel to and above the artery; subsequently they are separated by the hyoglossus muscle, the nerve being the more superficial;

but at the anterior border of the muscle we find the artery ascending, beneath the nerve, to the under surface of the tongue.

The branches of the lingual artery are—

a. The *hyoid*, a small artery which runs along the upper border of the os-hyoides, supplying the muscles.

b. The *dorsales linguæ*, small branches which ascend under cover of the hyo-glossus to supply the back of the tongue and the tonsils.

c. The *sublingual* usually arises near the anterior border of the hyo-glossus, and ascending divides into several branches, some of which supply the sublingual gland; others, the mucous membrane of the floor of the mouth, and the gums on the inner surface of the lower jaw. A branch (the artery of the frænum) generally inosculates above the frænum linguæ with a corresponding one from the opposite side; this is sometimes wounded in the operation of dividing the frænum in children, especially when the practical rule of directing the point of the scissors downwards and backwards is neglected. The sublingual is sometimes a branch of the facial artery.

The lingual artery is accompanied by two *veins*, which form, by their frequent communications, a kind of plexus around it. They commonly terminate in the internal jugular, but sometimes in the facial or the superior thyroid.

Upon attentive consideration of the parts, it will readily suggest itself that a ligature might be placed around either the superior thyroid or the lingual artery, in the first part of their course, without dividing more than the platysma and the cervical fascia. Nevertheless, considering the importance of the large vessels and nerves in the neighbourhood, the operation in either case is one of great nicety, and requires accurate anatomical knowledge. The best guide to the superior thyroid would be the ascending cornu of the thyroid cartilage. The best guide to the lingual would be the apex of the cornu of the os-hyoides. The artery is placed about two or three lines above the cornu, a little below the hypoglossal nerve; and behind the artery in most cases is the superior laryngeal nerve. It need scarcely be observed that the above-mentioned

guides are trustworthy only when the vessels are normal in their origin and course. We have known an instance in which a distinguished anatomist failed in an attempt to tie the lingual artery, because, as was subsequently ascertained, the vessel arose from the facial behind the submaxillary gland, and passed through the mylohyoid muscle to reach the tongue.

34. *Facial or external maxillary artery.*—This is generally the third branch of the external carotid, though it sometimes arises by a trunk common to it and the lingual. It passes forwards beneath the digastricus and stylo-hyoideus, traverses in a tortuous manner either the substance of the submaxillary gland or a groove on its under surface, and then ascends over the ramus of the jaw, where we find it on the anterior edge of the masseter muscle. Its subsequent course will be examined with the dissection of the face.

Its branches below the jaw are as follows:—

a. The *ascending palatine* ascends between the stylo-glossus and the stylo-pharyngeus muscles to the side of the pharynx, and ramifies chiefly upon the velum palati, tonsil, and Eustachian tube, inosculating with the descending palatine (a branch of the internal maxillary).

b. The *tonsillar,* sometimes a branch of the preceding, ascends close to the internal pterygoid muscle and supplies the tonsils.

c. Numerous small branches to the submaxillary gland.

d. The *sub-mental,* already described (see § 21).

The *facial vein* usually passes over the submaxillary gland immediately beneath the fascia, and terminates in the internal jugular: sometimes it joins the external.

35. *Occipital artery.*—This artery, generally the fourth branch of the external carotid, ascends backwards beneath the sterno-mastoid muscle and along the lower border of the digastricus to the interval between the mastoid process of the temporal bone and the transverse portion of the atlas: then it passes horizontally backwards beneath the splenius and trachelo-mastoid muscles, and finally, ascending over the occiput, divides into wide-spreading branches for the supply of the scalp. In the first part of its course it crosses the internal jugular vein, and is itself crossed by the

hypo-glossal nerve. Its branches with which we are now concerned are—

a. Muscular.—One especially to the sterno-mastoid, which it usually enters in company with the nervus accessorius.

b. The *meningeal.*—This small artery, often absent, ascends along the internal jugular vein, with which it enters the cranium and supplies the dura mater.

The occipital *vein* terminates in the internal jugular, or sometimes in the external.

36. *Posterior auricular.*—This, the fifth branch of the external carotid, is an artery of small size, which arises immediately above the digastric muscle. It ascends, under cover of the parotid gland, to the space between the cartilage of the ear and the mastoid process. Here it divides, and finally ramifies upon the back of the scalp and the cartilage of the ear. Of its branches we may notice the following:—

a. Small arteries to the parotid gland.

b. Stylo-mastoid.—This very constant little artery passes through the stylo-mastoid foramen to the tympanum of the ear.

37. *Posterior auricular nerve.*—We find this nerve close to the artery of the same name, between the cartilage of the ear and the mastoid process. It is derived from the facial nerve immediately after its exit from the stylo-mastoid foramen, and ascending backwards behind the ear, divides into branches which are distributed to the posterior part of the occipito-frontalis muscle and certain little muscles which move the ear, namely the retrahens and attollens aurem. It is commonly joined by one or two filaments from the auriculo-parotidean nerve (a branch of the cervical plexus).

38. Turning now our attention to the posterior triangle of the neck, we notice a muscle, the *levator anguli scapulæ,* which arises from the transverse process of the three or four upper cervical vertebræ, and descending backwards is inserted into the posterior border of the scapula between its spine and superior angle (see Arm, § 108). A little higher than this we observe a portion of another muscle, inserted into the outer surface of the mastoid process, and adjoining part of the occiput; this is the *splenius capitis.* It will be more fully exposed in the dissection of the back.

39. *Cervical plexus of nerves.*—We can now prepare a view of

this plexus, of which the superficial branches were traced at an early stage of the dissection (see § 5). The plexus is formed by the anterior branches of the four upper cervical nerves. It consists of a series of loop-like communications, which take place between these several nerves close to the transverse processes of the vertebræ, and it is situated in front of the scalenus posticus and the levator anguli scapulæ.

The plexus communicates with the hypoglossal nerve, the nervus accessorius, the superior cervical ganglion of the sympathetic, and sometimes with the pneumo-gastric nerve.

It furnishes branches to the following muscles:—the sterno-mastoid, trapezius, levator anguli scapulæ, the rectus capitis anticus major and minor, the rectus capitis lateralis, the scalenus posticus, the depressors of the os-hyoides (through the communicantes noni, see § 16), and to the diaphragm (through the phrenic nerve).

ANATOMY OF THE SUPRA-CLAVICULAR REGION.

40. The anatomy of the posterior inferior triangle, sometimes called the subclavian for obvious reasons, may be conveniently studied at this stage of the dissection. It is essential that the arm be placed by the side of the body, in order that the clavicle and the shoulder may not be raised above their natural position. The space we propose to examine is bounded by the clavicle, the outer border of the sterno-mastoid, and the posterior portion of the omo-hyoid muscle. The area of the triangle formed by the above-mentioned parts will, of course, vary in each case, just in proportion to the obliquity of the omo-hyoid muscle, and to the extent to which the sterno-mastoid is attached to the clavicle: the trapezius must also be taken into the account, for in some instances it comes so far forwards as almost to meet the sterno-mastoid. The depth at which the vessels and nerves contained in this space are situated not only depends upon the degree to which the clavicle arches forwards, but is also very materially varied, as one may readily ascertain in one's own person, by the elevation or depression of the shoulder.

Immediately beneath the skin covering this region we find the platysma myoides (see § 1), a few cutaneous branches of the cer-

vical plexus (see § 5 *c.*), and a layer of cervical fascia which binds down the omo-hyoid muscle to the clavicle (see § 7). Beneath this there is a deeper layer of fascia, which immediately covers the subclavian vessels and the brachial plexus of nerves, and descends with them beneath the clavicle into the axilla. Between these two layers of fascia we meet with more or less fat and cellular tissue, as well as several absorbent glands varying in number and size, which are continuous with those in the axilla. It will be easily understood how a collection of matter, originating in the axilla, may ascend in front of the vessels and project in the fossa above the clavicle.

Near the border of the sterno-mastoid muscle the external jugular vein passes through both layers of the fascia, and terminates in the subclavian: but before its termination it is commonly joined by the supra-scapular, the posterior scapular, and other unnamed veins proceeding from the surrounding muscles ; so that we have in this particular situation a confluence of veins, which are under any circumstances troublesome, and, when large or distended, exceedingly embarrassing.

The fascia and the glands should be carefully removed without disturbing the relative anatomy of the following objects contained in the space before us :—

Behind and nearly parallel with the clavicle is the supra-scapular or transversalis humeri artery, a branch of the thyroid axis. A little higher we may observe another artery, the transversalis colli, or posterior scapular (commonly a branch of the thyroid axis) which crosses rather tortuously the lower part of the neck towards the posterior superior angle of the scapula. But both these arteries, the last particularly, are subject to much irregularity in respect to their origin, and consequently to the first part of their course. The scalene muscles descend from the transverse processes of the cervical vertebræ to the first and the second ribs. The phrenic nerve is observed upon the surface of the scalenus anticus. The subclavian artery comes into view from behind the outer border of the scalenus anticus, and continues its course over the surface of the first rib. The subclavian vein also lies upon the rib, but in front of the scalenus anticus. The several large nerves constituting the

brachial plexus are seen emerging between the scalene muscles higher up than the subclavian artery.

41. *Scalene muscles.*—These several muscles, so called from their fancied resemblance to a scalene triangle, are situated by the side of the neck, and extend from the transverse processes of the cervical vertebræ to the first and the second ribs. Correctly speaking, they may be considered as intercostal muscles, since the transverse processes of the cervical vertebræ are really rudimentary ribs. It is proposed to describe them as three separate muscles—an anterior, a middle, and a posterior; the anterior and middle are attached to the first rib, the posterior to the second.

a. The *scalenus anticus* arises by aponeurotic slips from the anterior tubercles of the third, fourth, fifth, and sixth cervical vertebræ. The several slips unite to form a single muscle which descends outwards, and is inserted by a flat tendon into the upper surface of the first rib close to its inner border. A tubercle on the rib marks the point of its insertion.

b. The *scalenus medius,* the largest of the three portions, arises by pointed slips from the posterior tubercles of the transverse processes of the six lower cervical vertebræ. The muscle descends, increasing in size, and is inserted into the upper surface of the first rib, at a little distance behind the scalenus anticus: from this last muscle it is separated by the subclavian artery and the brachial plexus of nerves.

c. The *scalenus posticus* is the smallest of the three portions. It arises by tendinous slips from the posterior tubercles of the transverse processes of the two or three lower cervical vertebræ, and is inserted by a thin tendon into the second rib, between its tubercle and angle. Its insertion cannot be properly seen till the removal of the arm.

Action.—The scalene muscles can either assist in raising the first and second ribs, as in a deep inspiration, or they can bend the cervical portion of the spine, according as the one or the other attachment be the fixed point.

42. *Phrenic nerve.*—This nerve is seen lying upon the surface of the scalenus anticus muscle. By tracing it upwards we find that it arises most commonly from the fourth and fifth, and some-

times also from the third, cervical nerves. It descends almost perpendicularly, enters the chest between the subclavian artery and vein, close to the inner border of the scalene muscle, and then continues its course between the pericardium and the pleura, in front of the root of the lung, to the diaphragm.

a. The phrenic nerve is frequently joined by a filament from that branch of the brachial plexus which supplies the subclavius muscle. It is important to be aware that cases sometimes, though rarely, occur in which this comparatively insignificant filament is a branch of considerable size, and forms the greater portion of the phrenic itself. We have met with two instances in which this supplementary branch was larger than the normal trunk; in both it crossed over the subclavian artery in the third part of its course, and would probably have been injured in the operation of tying this vessel.

43. COURSE AND RELATIONS OF THE SUBCLAVIAN ARTERIES.—Since the subclavian artery on the left side differs from that on the right, not only in the origin but also in its relations of the first part of its course, it becomes necessary to speak of each separately: we shall therefore describe the right subclavian first, and then mention the differences which exist between it and the left.

a. Right subclavian.—The right subclavian artery is one of the two great branches into which the arteria innominata divides near the sterno-clavicular joint. It passes upwards and outwards behind the scalenus anticus muscle, and then inclines downwards over the first rib, at the lower border of which it takes the name of axillary. Thus the artery describes a slight curve, of which the greatest convexity is between the scalene muscles. The height to which the arch ascends varies in different cases. Generally speaking, it rises higher in women than in men, on the right side than on the left, and in individuals with long necks than those with short ones. The arch also ascends higher in those persons in whom the first rib is more oblique than usual.

For the more accurate examination of its several relations, it is convenient to divide the course of the artery into three parts: the first comprises that portion between the trachea and the inner border of the scalenus anticus; the second includes as much as lies

between the scalene muscles; the third comprises the remainder of the vessel, which rests upon the surface of the first rib, external to the scalenus anticus. Each of these portions we shall now separately describe.

The *first* portion of the artery lies deeply seated in front of the apex of the lung, and therefore in close contact with the pleura. It is covered by the sterno-mastoid, sterno-hyoid, and thyroid muscles, and a strong layer of fascia. Immediately in front of the artery we observe the confluence of the internal jugular and the subclavian veins. On the inner side of the internal jugular the artery is crossed by the pneumogastric nerve and some cardiac filaments of the sympathetic; behind the artery there is the recurrent laryngeal branch of the pneumogastric and the sympathetic nerve.

In the *second* part of its course, where the artery lies between the scalene muscles, it is covered by the platysma, the clavicular origin of the sterno-mastoid, the cervical fascia, and the scalenus anticus, which separates it from the subclavian vein, and the phrenic nerve.

In the *third* part of its course the artery lies upon the surface of the first rib. It is here comparatively superficial, being covered only by the platysma, and two layers of cervical fascia. The subclavian vein is situated in front of and a little below the artery, nothing but a delicate septum of fascia intervening. The external jugular, and probably one or more tributary veins, will also be observed crossing over the artery. Above the artery, and nearly on the same plane, are the great trunk nerves of the brachial plexus. Of these nerves the lowest runs so nearly parallel and in such close contact with the artery, that even an accomplished surgeon has mistaken the nerve for the vessel in an attempt to place a ligature round the subclavian for the cure of an aneurism in the axilla. Indeed, the nerve and artery are so close together that they have even both been included in the same ligature.

b. Left subclavian artery.—This is the last of the three great branches which arise from the arch of the aorta. It ascends out of the chest nearly parallel with the left carotid, and then forms an arch in front of the apex of the lung, so as to reach the inner border of the scalenus anticus, behind which it runs over the

surface of the first rib. It is manifest, therefore, that it differs from the right subclavian in being longer and more vertical in the first part of its course. As it turns outwards in front of the apex of the lung to the scalenus muscle, the artery is covered by the confluence of the subclavian and internal jugular veins. The pneumo-gastric nerve runs parallel with and rather in front of the artery. The phrenic nerve also descends in front of the artery near the inner margin of the scalenus.

The thoracic duct bears an important relation to the left subclavian artery. It ascends out of the chest between the œsophagus and the vessel in question, and after forming an arch with the convexity directed upwards behind the internal jugular vein, it most commonly terminates in the subclavian vein near its junction with the jugular. The duct is so thin and transparent that it easily escapes observation: we shall most readily find it by drawing the internal jugular vein towards the trachea, and by searching with the handle of the scalpel in the loose tissue on the inner edge of the scalenus anticus, sometimes in front of, sometimes behind the vertebral vein.

Before we proceed to trace the branches of the subclavian artery it is advisable briefly to consider some of the more important points relating to the operation of placing a ligature around this vessel.

It will at once suggest itself that to tie the artery in the first part of its course, namely on the inner edge of the scalenus anticus muscle, is an operation of very great difficulty and danger, even supposing the parts to be in a normal position. The great depth at which the artery is placed, the number and size of its branches, the large veins by which it is covered, its connexion with the pneumo-gastric, recurrent laryngeal, phrenic, and sympathetic nerves, and above all its close contiguity with the pleura, form a combination of circumstances so formidable that one cannot be surprised the operation has never been performed with success.

In the second part of its course, namely between the scalene muscles, the artery is more accessible. It would be necessary to divide the clavicular origin of the sterno-mastoid, the cervical fascia, and the scalenus anticus muscle, in order to reach the vessel;

the phrenic nerve and the subclavian vein would be the chief objects exposed to injury. This operation is said to have been successfully performed by Dupuytren in the year 1819.* More recently it has been performed by Dr. Warren, of Boston. The patient recovered, though the pleura was wounded during the operation.†

But in the last part of its course, that is, on the outer side of the scalenus, the artery may be tied with comparative facility. Besides its more superficial position the artery offers here this favourable advantage, that no branches, in the generality of subjects at least, arise from it. The external incision should be made from three to four inches in length parallel with the upper border of the clavicle. We should have to divide the platysma, some of the supra-clavicular nerves, and the cervical fascia. The external jugular vein must be drawn aside, or divided and tied at both ends. With the finger and the handle of the scalpel we must then make way through the cellular tissue down to the outer edge of the scalenus anticus muscle, behind which the artery will be found lying upon the first rib. In a well-marked rib there may be felt at the insertion of the scalenus a tubercle which is a very good guide to the artery. It will be necessary to divide a layer of fascia which immediately covers the vessel before the aneurismal needle can be introduced around it. The needle should be passed between the artery and the vein so that the point of it in rising may be less likely to injure the thin coats of the vein.

In the hands of a surgeon possessed of a practical knowledge of anatomy the operation above described would appear to be comparatively easy, and indeed is so, provided all circumstances be favourable; but this is by no means always the case. It often happens that the aneurismal or other tumour, on account of which the operation is performed, elevates the clavicle beyond its natural level, and so disturbs the relative situation of the parts that to expose the artery and place a ligature around it becomes exceedingly difficult. Under such circumstances one cannot be surprised

* Hyrtl. Handbuch der topographiscen anatomie, vol. i. p. 344.

† Med. Chirurg. Trans., vol. xxix. p. 25.

that even distinguished anatomists have committed unfortunate mistakes. Sir Astley Cooper* completely failed in one instance. In another, Dupuytren perforated the artery with the point of the aneurismal needle, and included one of the nerves of the brachial plexus in the ligature: fatal hæmorrhage was the result.† We know, too, an instance in which the large nerve which runs parallel with the artery was mistaken for it and tied; the surgeon being deceived by the pulsation communicated from the artery to the nerve.

44. *Branches of the subclavian artery.*—These extend so far and wide in all directions that in the present dissection we can trace them but for a very short distance. They are five in number—the vertebral, the thyroid axis, the internal mammary, the superior intercostal, and the deep cervical. Once for all let it be remembered that *most commonly* they arise from the subclavian *about* the first part of its course, but in this respect we often meet with irregularity; the most frequent is, that one of the branches usually derived from the thyroid axis (*i. e.* the transversalis colli or the transversalis humeri) arises from the subclavian in the third part of its course.

45. The *vertebral artery,* the first and the largest branch, arises from the upper part of the subclavian. For a short distance after its origin it lies behind the internal jugular vein in the interval between the scalenus anticus and the longus colli muscles. Here it enters the foramen in the transverse process of the sixth or sometimes the fifth cervical vertebra, and ascends vertically through the series of foramina in the transverse process of the succeeding vertebræ. After passing through the foramen of the atlas the vessel alters its direction, curves backwards behind the articular process of this bone along a shallow groove observable upon its posterior arch, and again ascending, enters the skull through the foramen magnum, and unites near the lower border of the "pons Varolii" with its fellow of the opposite side to form the basilar artery.

* London Medical Review, vol. ii. p. 300.

† Edinburgh Med. and Surg. Journal, vol. xvi. 1820.

The vertebral artery is accompanied by delicate nervous filaments which proceed from the inferior cervical ganglion of the sympathetic, and form a plexus around the vessel traceable in some cases as high as the third or fourth cervical vertebra. These filaments communicate with the spinal nerves forming part of the brachial plexus.

Being intended chiefly for the supply of the brain, it gives off no branches of any consequence in the neck, excepting a few small ones to the deeply-seated muscles; it furnishes, however, to the spinal cord and its membranes a series of small arteries which pass through the several inter-vertebral foramina.

The *vertebral vein* is formed by small branches near the foramen magnum, descends in front of the artery through the series of foramina in the transverse process, and joins the brachio-cephalic vein. It receives veins from the cervical portion of the spinal cord, and sometimes the vein corresponding to the ascending cervical artery.

The vertebral vein, in the generality of subjects, takes no share in returning the blood from the brain; but in some cases it communicates with the great lateral sinus by a large branch which traverses the posterior condyloid foramen.

46. The *thyroid axis* arises from the fore part of the subclavian near the inner edge of the scalenus anticus, and after a course of about one quarter of an inch divides into several branches which pursue different directions. They are the inferior thyroid, the transversalis colli, the supra-scapular, and the ascending cervical.

a. The *inferior thyroid* artery ascends for a short distance upon the longus colli muscle, and then curves downwards, behind the sheath of the large vessels of the neck and the sympathetic nerve, to the under surface of the thyroid body, in which it communicates freely with the other thyroid arteries. It gives small branches to the trachea, the œsophagus, and the larynx.

b. The *ascending cervical,* an artery of variable size, often arises from the inferior thyroid. It ascends in the interval between the scalenus anticus and the rectus capitis anticus major muscles, and terminates in small branches some of which supply the muscles

in front of the spine, others enter the inter-vertebral foramina, and are distributed to the spinal cord.

c. The *supra-scapular* artery (transversalis humeri) passes outwards over the scalenus anticus muscle, and then runs behind and nearly parallel to the clavicle towards the superior border of the scapula, where it divides into branches some of which ramify above, others below, the spine of this bone. (See ARM, § 3.)

d. The *transversalis colli* artery, though commonly a branch of the thyroid axis, frequently arises from the subclavian in the last part of its course. It runs tortuously over the scalene muscle and the great nerves of the brachial plexus, passing sometimes between them, and disappears beneath the levator anguli scapulæ. Its further progress is dissected with the arm (see ARM, § 112). Beneath the anterior border of the trapezius muscle it gives off the *superficial cervical* artery, which distributes branches to the levator anguli scapulæ and trapezius, as well as the adjacent cervical glands.

The veins corresponding to the supra-scapular and transversalis colli arteries commonly terminate in the external jugular, but sometimes in the subclavian. The inferior thyroid vein, when present, crosses in front of the common carotid artery, and terminates in the internal jugular.

47. *Internal mammary.*—This artery arises from the subclavian opposite to the thyroid axis. It enters the chest behind the subclavian vein, and descends longitudinally between the cartilages of the ribs and the pleura, about half an inch more or less from the sternum. Its further progress will be examined in the dissection of the chest. The corresponding vein most frequently terminates in the vena innominata; occasionally, on the right side, in the superior cava.

48. *Superior intercostal.*—This artery is given off by the subclavian rather behind the scalenus anticus muscle, and is not at present easily discovered. It descends into the chest, passing over the neck of the first and generally the second rib, and furnishes the arteries proper to the two upper intercostal spaces. It usually inosculates with the first intercostal branch of the aorta. The corresponding vein terminates on the right side in the vena-azygos;

on the left in the vena innominata. But deviations are frequently met with.

49. *Deep cervical.*—This artery arises from the subclavian close to the preceding; very frequently there is a trunk common to both. It passes to the back of the neck between the first rib and the transverse process of the last cervical vertebra, and mounts up between the complexus and the semi-spinalis colli supplying these muscles.

50. *Subclavian vein.*—This vein, a continuation of the axillary, has an equal extent with the corresponding artery. It should be observed that it does not form an arch like the artery, but that it proceeds more nearly in a straight line over the surface of the first rib to its junction with the internal jugular. Consequently throughout its whole course it is situated on a plane anterior to and a little lower than the artery, from which it is separated by the anterior scalene muscle, the phrenic and pneumo-gastric nerves, and a thin layer of fascia.

51. *Brachial plexus of nerves.*—The large nerve-cords forming the plexus which supplies the nerves of the upper extremity are the anterior divisions of the four lower cervical nerves, and of the greater part of the first dorsal. Emerging from the inter-vertebral foramina they appear between the anterior and middle scalene muscles, and proceed downwards and outwards with the subclavian artery beneath the clavicle into the axilla. To this bundle of large nerves taken collectively the name "plexus" is given, on account of their mutual interlacement. The plexus at its root or base is wide in extent, and situated higher than the subclavian artery, and nearly on the same plane; but in proportion as the plexus descends beneath the clavicle its several component nerves gradually converge, and finally, in the axilla, completely surround the artery by their mutual interlacement.

It will be remembered that the plexus is crossed superficially by the omo-hyoid muscle, and by the supra-scapular and transversalis colli arteries. For an account of the manner in which the nerves are arranged in the formation of the plexus, see Arm, § 18.

The plexus gives off above the clavicle the following nerves :—

a. Nerve to subclavius muscle.—This usually proceeds from

the fifth cervical, and crosses the subclavian artery in the third part of its course. It frequently sends a filament which passes either in front of or behind the subclavian vein and joins the phrenic. The fact of this filament being in some few instances very much larger than usual has been already alluded to (see § 42 *a*).

b. Nerves to the *scalene* and the *longus colli* muscles.

c. Nerve to the *rhomboid* muscles.—This generally arises from the fifth cervical nerve, and accompanies the posterior scapular artery beneath the levator anguli scapulæ, which, as well as the rhomboid muscles, it supplies. See Arm, § 109.

d. The *supra-scapular* nerve commonly arises from the sixth cervical, and proceeds outwards to the notch in the upper margin of the scapula, where it meets with the corresponding artery, and terminates partly in the supra-spinatus and partly in the infra-spinatus muscle. See Arm, § 124.

e. The *nerve* (commonly called *external respiratory*) to the *serratus magnus.*—This arises from the fifth and sixth cervical nerves, appears first between the middle and posterior scalene muscles, and then descends longitudinally behind the plexus and the subclavian vessels to the outer surface of the serratus magnus, to which it is exclusively distributed. See Arm, § 15.

f. Nerves (commonly called *anterior thoracic*) to the *pectoral muscles.*—Generally two in number; they pass beneath the clavicle, one in front of and the other behind the artery. See Arm, § 9.

g. A branch forming one of the roots of the phrenic nerve. It arises from the fifth cervical nerve.

It only remains to be observed that the upper cord of the brachial plexus receives a branch from the lower cord of the cervical plexus, and that each of its several component nerves communicate by slender filaments in front of the spine with the sympathetic system.

After the examination of the lower part of the neck it is quite optional whether we proceed to the dissection of the face or that of the chest. Those who consider the anatomy of the chest the

more appropriate, must turn to that part of this work in which it is described.

DISSECTION OF THE FACE.

52. It requires considerable care and some practice to make a good dissection of the face. The muscles are numerous and complicated; some of them, particularly those of expression, are interwoven with the subcutaneous tissue and closely united to the skin; their fibres are often pale and indistinct, and separated by more or less fat and cellular membrane. As might be expected, the face is amply supplied with motor and sensitive nerves, of which the ramifications extend far and wide. For these reasons it need not be matter of discouragement if in a first or even a second attempt the young anatomist fail to make a satisfactory display of the parts he now proposes to examine.

In order to make the cheeks as tense as possible the mouth should be filled with horse-hair, and the lips stitched together. It is recommended to make an incision down the mesial line, and another from the condyle of the jaw to the angle of the mouth. In reflecting the skin we must be careful to leave the subcutaneous tissue.

It may be well at once to state that the great motor nerve of the face is the portio dura, or facial division of the seventh cerebral nerve. It emerges from the stylo-mastoid foramen, and divides into many branches, which pass through the parotid gland and run forwards, subdividing and spreading widely to supply the muscles of the face.

The sensitive nerves of the face are supplied by branches from the three great divisions of the fifth cerebral nerve: there is the supra-orbital branch, the infra-orbital, and the mental, each being named after the respective foramen in the bone through which it emerges upon the face. No other nerve takes any share in conferring sensation upon the face except one: we allude to the auriculo-parotidean branch of the cervical plexus, which assists in supplying the skin covering the parotid gland and the adjoining part of the cheek.

In removing the skin from the middle of the nose a small nerve may be observed on either side called the *naso-lobular*. It appears between the bone and the cartilage, and divides into filaments which supply the apex and the ala of the nose.

Musculus risorius (Santorini).—In the dissection of the neck (see § 1) it was mentioned that some of the fibres of the platysma myoides pass over the angle of the jaw and are prolonged on the side of the cheek as far as the angle of the mouth, where they intermingle with the orbicularis oris and other muscles in this situation. In some subjects a few scattered fibres may be traced as high as the zygomatic muscles, or even the orbicularis palpebrarum. But the name prefixed to this paragraph was applied by Santorini* to a narrow band of muscular fibres distinct from the platysma, which arise from the fascia covering the masseter muscle, and pass more or less obliquely inwards to the angle of the mouth. This little cutaneous muscle is very variable in its degree of development, and in many subjects is entirely absent. Its *action* is implied by its name.

In the examination of the several muscles of the face it is convenient to arrange them, so far as possible, under three heads; appertaining respectively to the mouth, the nose, the eyebrows and lids. It matters little which group of muscles be first selected for study; perhaps it is more convenient to begin with those connected with the mouth.

The muscles, then, of the mouth are arranged in this wise: there is an orbicular or sphincter muscle of considerable size surrounding the lips; from this, as from a common centre, certain muscles diverge and are fixed into the surrounding bones; thus the various movements of the mouth are effected. The muscles are exceedingly well named, elevators, depressors, &c., according to their respective action.

53. *Orbicularis oris*.—This is a flat muscle, nearly an inch in breadth, and elliptical in form, corresponding to the aperture of the mouth. It varies in size and thickness in different individuals, and thus produces the great variety in the prominence of the lips.

* Jo. Dom. Santorini Observ. Anat. 4to. Rot. 1724.

It is necessary to observe that its fibres do not surround the mouth in one unbroken series, so as to form a complete muscular ellipse, but that those of the upper and lower lip respectively decussate at the angles of the mouth, and intermingle with the fibres of the buccinator and other muscles which converge from different parts of the face. The superficial surface of the muscle is intimately connected with the lips and the surrounding integument; the deep surface is separated from the mucous membrane of the mouth by the labial glands and the coronary vessels.

Action.—This is the antagonist of all the muscles which move the lips. Upon a nice balance of their opposite actions depends the varied play of the mouth with which every one is familiar.

In strong muscular lips the upper part of the orbicularis sends a small subcutaneous slip of muscle from each side along the septum nasi nearly to the apex. The interval between the two slips corresponds to the furrow below the nose. This is the "naso-labialis" or "depressor septi narium" of some anatomists.*

54. *Depressor anguli oris.*—This muscle is triangular in form. It has a broad origin from the outer surface of the base of the lower jaw, below the "foramen mentale" along a line corresponding to the two bicuspid and the two anterior molar teeth. The fibres ascending converge towards the angle of the mouth, where they intermingle with the zygomatici and the upper part of the orbicularis oris.

Action.—This is an important muscle in a physiognomical point of view, as it acts in all sorrowful emotions. We see its effects remarkably well in crying.

55. *Depressor labii inferioris,* or *quadratus menti.*—We must reflect the preceding in order to obtain a complete view of this muscle. It arises from that part of the outer surface of the ramus of the jaw which corresponds to the canine and the two or three teeth next in succession. The fibres ascend and terminate partly in the skin of the lower lip and partly in the orbicularis oris. It covers the vessels and nerve which emerge from the "foramen mentale."

56. *Levator menti.*—To display this muscle we must evert the

* Haller, Albinus.

lower lip and remove the mucous membrane on either side of the frenum. It arises from a depression in front of the symphysis of the jaw immediately below the incisor teeth. The fibres descend and expand into the skin of the chin.

57. *Zygomatici.*—These two narrow muscles extend from the zygoma to the angle of the mouth. The *zygomaticus major* arises from the lower part of the outer surface of the malar bone near the zygomatic suture. The fibres descend obliquely towards the angle of the mouth, where they intermingle with the inferior fibres of the orbicularis oris and the depressor anguli oris. The *zygomaticus minor* arises from the outer surface of the malar bone anterior to the major, descends obliquely forwards, and joins the outer border of the levator labii superioris, or the orbicularis oris. It is often absent. The action of these muscles is seen in laughing.

Previous to the examination of the orbicularis palpebrarum it is advisable to notice the tendo oculi, or internal palpebral ligament. To make the tendon more apparent the tarsal cartilages should be drawn outwards.

58. *Tendo oculi* (internal palpebral ligament).—This little tendon is about two lines in length, and is readily felt beneath the skin at the inner angle of the eye. It is attached to the nasal process of the superior maxillary bone in front of the lacrymal groove, passes horizontally outwards, and divides into two portions, one of which is connected with the upper, the other with the lower tarsal cartilage. The tendon crosses the lacrymal sac a little above the centre, and gives off a fascia which covers the sac and is attached to the margins of the groove which contains it. To obtain a view of this fascia we must reflect that portion of the orbicularis palpebrarum which covers the sac.

In the operation of puncturing the lacrymal sac the knife is introduced immediately below the tendon, in a direction downwards, outwards, and a little backwards. There is nothing to divide but the skin, a few fibres of the orbicularis palpebrarum, and the fibrous expansion derived from the tendo oculi. The angular artery and vein will not be endangered, being situated on the inner side of the incision.

59. *Orbicularis oculi.*—This muscle consists of a broad subcutaneous stratum of muscular fibres which surrounds the eyelids

and the margin of the orbit. The fixed point of the muscle is on the inner side of the orbit. For the sake of perspicuity we shall consider, first, the attachment of the fibres of the upper curve, and secondly, the attachment of the fibres of the lower. The fibres, then, of the upper curve are attached to the internal angular process of the frontal bone, and to the nasal process of the superior maxillary bone; those of the lower curve are attached to all the orbital margin of the superior maxillary bone below the tendo oculi, and also to the fibrous covering of the lacrymal sac. The external fibres, those namely which form the circumference of the muscle, completely encircle the orbit; and a few stray ones extend in a scattered manner for some distance beyond its margin over the brow, temple, and cheek, in which latter direction they mingle with the zygomaticus minor and the levator labii superioris.

Those fibres of the muscle which belong to the eyelids, (orbicularis palpebrarum) are thin and pale. They arise almost exclusively from the upper and lower surface of the tendo oculi, and form over each eyelid a series of elliptical curves which meet at the external canthus of the lids. The degree of their curvature becomes less as they approach the margin of the lids, so that a thin stratum of fibres proceeds nearly straight close to the eyelashes. This was first pointed out by Riolanus,* and described as "musculus ciliaris."

On the eyebrow the orbicularis is intimately connected to the subcutaneous tissue and the skin, as well as the occipito-frontalis muscle. On the cheek it is separated from the skin by a greater or less quantity of fat. But on the lids no fat is ever found; nothing intervenes between the skin and the muscle but a quantity of loose cellular tissue, in order that there may be no impediment to the free play of the lids.

Action.—This muscle, according to the extent and force of its contraction, acts in a variety of ways in protecting the eye. For instance, supposing the eye to be threatened by a blow, the muscle suddenly and violently contracts, presses the eye back into the orbit, and draws in the skin of the brow and the cheek so as to

* Anthropologia, lib. v. cap. 10.

form a soft cushion in front of the orbit. The cushion itself may be severely injured, as is seen in the common occurrence of a "black eye," so called, but the globe generally escapes unhurt. When the eye is simply closed, as in the act of winking, only the palpebral portion of the muscle is used. It need scarcely be mentioned that the object of this movement is to moisten the transparent coat of the eye, and remove any foreign particles from its surface. The reason why the upper lid descends is because the fixed point of the muscle is below the middle of the eye, and the least knowledge of mechanics is sufficient to explain how the motion is effected with such rapidity.

a. Tensor tarsi (musculus sacci lacrymalis).—This has been particularly described by Horner,* an American anatomist; hence it is sometimes called Horner's muscle. In point of fact it should not be considered a distinct muscle, but rather as a portion of the ciliaris. If the fibres of this muscle be carefully traced at the inner angle of the eye, it may be observed that some of them are prolonged backwards behind the tendo oculi, so as to be attached to the ridge on the lacrymal bone. The muscle, by pressing the tarsal cartilages against the globe of the eye, is presumed to facilitate the entrance of the tears into the lacrymal ducts.

60. *Corrugator supercilii.*—To see this muscle, the orbicularis must be reflected from the upper and inner margin of the orbit. It arises by fleshy fibres from the superciliary ridge of the frontal bone immediately above the nasal bone. The fibres ascend obliquely outwards, and are lost in the under surface of the orbicularis and occipito-frontalis muscles. It is the proper muscle of frowning.

61. *Pyramidalis nasi.*—This muscle is situated on the dorsum of the nose on each side of the mesial line, and may very fairly be regarded as a prolongation of the occipito-frontalis. It diverges from its fellow as it descends and mingles with the fibres of the triangularis nasi. The *action* of this slip of muscle is to elevate

* Philadelphia Journal, Nov. 1824. But this muscle was accurately described by Rosenmüller in his Handbuch der Anatomie. Leipzig, 1819.

the skin on the bridge of the nose; as, for instance, in the expression of surprise.

Since the present is a fitting opportunity to examine the structure of the eyelids, we postpone for a short time the dissection of the remaining muscles of the face. Those who object to this interruption are referred to § 63.

62. Structure of the eyelids.—The eyelids are composed of many different tissues arranged in successive strata one beneath the other; therefore they can be conveniently examined in their order of stratification. There is—1, the skin; 2, the orbicularis palpebrarum; 3, the expanded tendon of the levator palpebræ (in the upper lid only); 4, the tarsal cartilage; 5, mucous membrane. These several structures are separated by an abundance of cellular tissue, which for very good reasons never contains fat.

a. The *skin* of the eyelids is remarkably smooth and delicate, and in young persons so transparent that we can see the ramifications of the subcutaneous vessels. When the eyes are open a deep fold is occasioned in the skin of the upper lid by its being more or less drawn under the edge of the orbit.

b. The *orbicularis palpebrarum* has been already described. (See § 59.)

c. The *levator palpebræ* is a long thin muscle, which arises in a pointed manner from the back of the orbit, gradually becomes broader, and terminates in a thin aponeurosis which spreads out over the tarsal cartilage, and is inserted into its ciliary margin. It will be more fully examined in the dissection of the orbit.

d. *Tarsal cartilages.*—These are plates of fibro-cartilage which support and give the figure to the eyelids. There is one for the upper and another for the lower lid, and the two are connected at the angles (commissures or canthi) of the lids through the medium of fibrous tissue. One may best examine them by everting the lids. Each cartilage in great measure resembles its lid in form. The upper is therefore much the larger of the two, is broad in the middle, and gradually becomes narrower at either end; so that its figure is like a small segment of a circle, the arc of which is towards the brow, and the cord at the margin of the lid. The

lower is nearly of uniform breadth throughout. Both are thicker on the nasal than the temporal side. They are connected to the margin of the orbit, and so maintained in proper position, by the tendo oculi already described, § 58; and by what is called the *broad tarsal ligament:* this consists of a layer of fibrous tissue which extends from the circumference of the cartilages (upper and lower) to the margin of the orbit. This, as one might expect, is more dense and resisting on the temporal side, where the eye is more exposed to injury.

The ciliary margin is the thickest part of the tarsal cartilages, and presents for our observation a very beautiful mechanism. We notice that their edges are not, through their entire thickness, on the same plane; but that the inner edge of each is sloped or bevelled off as it were; consequently, when the lids are closed, there is formed with the globe of the eye a triangular channel. This channel is very narrow towards the temples, but gradually increases in size towards the nose, and its use is to conduct the tears to the puncta lacrymalia.

The *puncta lacrymalia* are two pin-hole apertures, easily discovered at the inner angle of the upper and lower lid, and they are the orifices of the canals which convey the tears to the lacrymal sac. It is observed that they project slightly backwards, so as not to be obstructed by the closure of the lids.

In the introduction of probes for the purpose of opening the contracted puncta, or of examining the lacrymal canals, it is of importance to be aware of the exact direction of these tubes. By passing a bristle into one of them, say the lower, being the larger, we find that it does not run straight from the punctum to the sac, but that it proceeds for a short distance perpendicularly, and then, dilating into a small pouch, makes a sharp bend inwards to the lacrymal sac. When, from any cause, the tears are secreted in greater quantity than usual, and cannot discharge themselves through the ducts, they overflow the channel and trickle down the cheek.

e. The *eyelashes* (cilia) are planted in rows along the edge of the tarsal cartilages. They are largest in the middle of the lids; those of the upper lid are more numerous and larger than those in

the lower, and rather curved with the convexity downwards: the cilia of the lower lid take just the opposite direction. Each lash is thickest at the root, and gradually tapers to a fine point.

f. The *Meibomian glands,* so called after the anatomist* who first described them, are a series of sebaceous glands situated on the under surface of each of the tarsal cartilages. In the upper lid there may be from thirty to forty of them, but there are not quite so many in the lower. They become immediately apparent on everting the lid, and are seen running in parallel longitudinal rows in grooves of the cartilage. When examined with the microscope they are found to consist of a central tube, round the sides of which there are a number of openings leading to short cæcal dilatations.† The orifices of these glands are situated on the free margin of the lid behind the lashes. Their use is to secrete an unctuous substance which prevents the lids from sticking together.

g. Caruncula lacrymalis.—This name is given to a small reddish body situated at the inner corner of the eye. It is composed of an aggregation of small glands covered by the mucous membrane. In some instances minute hairs grow upon it.

h. The conjunctival coat of the eyelid will be described with the anatomy of the eye. We would merely observe here, that it is more vascular than the conjunctival coat of the eye, and that it presents a number of minute papillæ. When these papillæ become enlarged and aggregated by inflammation, they give rise to the disease called "granular lids."

Such, in outline, is the structure of the eyelid. Its use must be apparent to every one. It shuts out the light during sleep, protects the eye from accidental violence, and by its winking motion spreads a clear fluid over the cornea, removing at the same time from its polished surface any particle of dust which might irritate the eye and impede the transmission of light.

Proceeding with the dissection of the muscles of the face, we must now raise the lower circumference of the orbicularis oculi, in

* H. Meibom, de Vasis palpebrarum novis, Helmstedt, 1666.

† Arnold, Tab. anat. fasc. 2, Tab. 1.

order to see the origin of the elevators of the upper lip and the nose.

63. *Levator labii superioris alæque nasi.*—This muscle arises from the nasal process of the superior maxillary bone near the tendo oculi, and from the surface of this bone near the lower margin of the orbit. The fibres proceed downwards, and divide into two portions; of which the outer, comprising two-thirds of the muscle, terminates in the skin of the upper lip, mingling with the orbicularis oris and the levator labii proprius; the inner covers the posterior third of the ala of the nose, and terminates in the skin and cartilage of this organ. It acts chiefly in expressing the smile of derision, and the scornful affections of the mind. The habitual use of this muscle especially, and also of the muscles of the face generally, occasions corresponding permanent folds in the skin, which are, to a certain extent, indicative of the feelings and passions of the individual.

64. *Levator labiisu perioris.*—This muscle has a broad origin immediately above the infra-orbital foramen, partly from the superior maxillary and partly from the malar bone. The fibres descend, inclining inwards, to the upper lip, and mingle with those of the orbicularis oris. This muscle is nearly an inch in breadth at its origin, and it covers the vessels and nerves which emerge from the infra-orbital foramen.

65. *Levator anguli oris.*—This muscle lies immediately beneath and is partially covered by the preceding. It has a broad origin from the canine fossa of the superior maxillary bone, immediately below the infra-orbital foramen. The fibres descend, inclining outwards, and converge towards the angle of the mouth, where they intermingle with the lower fibres of the orbicularis oris and the depressor anguli oris.

We have now to examine two muscles belonging to the nose—the triangularis or compressor nasi, and the depressor alæ nasi.

66. *Triangularis nasi.*—This muscle arises from the superior maxillary bone near the ala of the nose. Its origin is concealed by the levator labii superioris alæque nasi. The fibres, diverging, spread over the side of the nose; the lower ones mingle with those of the depressor alæ nasi; the upper are continuous with those of

the pyramidalis; the middle form, with the corresponding muscle of the opposite side, a fibro-cellular expansion on the dorsum of the nose. Its peculiar *action* is not thoroughly understood: by some it is considered a compressor, by others a dilator of the nose.

67. *Depressor alæ nasi.*—This muscle is situated between the mucous membrane and the muscular structure of the upper lip. To expose it, therefore, the upper lip must be everted and the mucous membrane removed. It arises from the alveolar surface of the upper jaw, above the second incisor and the canine teeth. The fibres ascend and terminate in the posterior part of the septum and the ala of the nose.

68. Besides the muscles above described, we find, in connexion with the cartilages of the ala of the nose, pale muscular fibres, in which, in most cases, no definite arrangement can be traced. In subjects, however, very favourable for the purpose, the two following muscles may be discovered:—

a. The *dilatator narium anterior* arises from the upper border of the inferior cartilage of the nose: thence, its fibres, proceeding downwards, are lost upon the edge of the nostril.

b. The *dilatator narium posterior* arises from the margin of the ascending process of the superior maxillary bone, and from the small sesamoid cartilages; the fibres thence descending terminate in the skin of the posterior part of the edge of the nostril. It is situated beneath all the other muscles of the nose.

The little muscles acting upon the cartilages of the nose contribute in some degree to express the condition of the mind. Some of them dilate the nostrils; as, for instance, in dyspnœa; others contract them, as in smelling, when we sniff up the air towards the seat of the olfactory nerve. Though apparently feeble they are sufficiently strong to answer their purpose, in consequence of the facility with which the several cartilages of the nose are moved upon each other.

69. *Buccinator.*—This muscle consists of a flat stratum of fibres which form the foundation of the cheek. It arises from the alveolar border of the upper jaw, near the three last molar teeth, and from the alveolar border of the lower jaw, near the two last molars. But this is not all; for in the interval between these

points of origin its fibres are attached to the so-called pterygo-maxillary ligament, which is the intermediate bond of connection between them and the fibres of the superior constrictor of the pharynx. We shall presently see that these two muscles, conjointly, form an uninterrupted muscular wall for the side of the mouth and the pharynx. The fibres of the buccinator proceed forwards from their origin, and gradually converge towards the angle of the mouth, lying on a deeper plane than the other muscles in this situation. They are finally lost in the muscular structure of the lips; but with a little care we may observe that the middle fibres of the muscle cross each other at the angle of the mouth before their termination. The duct of the parotid gland passes through the muscle near the second molar tooth of the upper jaw.

The chief *action* of the muscle is to keep the food well between the teeth during mastication. It can also widen the mouth. Its power of forcibly expelling air from the mouth, as, for instance, in whistling or playing on a wind instrument, has given rise to its peculiar name.

a. Buccal fascia.—The buccinator muscle is covered by a layer of fibrous tissue, which adheres closely to its surface, and is attached to the alveolar border of the upper and the lower jaw. This structure is comparatively thin over the anterior part of the muscle, but much more dense and resisting posteriorly, in which direction it is continuous with the aponeurosis of the pharynx. By some anatomists it is called the "bucco-pharyngeal" fascia, since it supports and strengthens the muscular walls of these cavities. It is in consequence of the resistance of this fascia that abscesses do not readily burst into the mouth or the pharynx.

b. Molar glands.—These glands, not more than three or four in number, are situated immediately outside the posterior part of the buccinator. They are about the size of a split pea, and their secretion is conveyed to the mouth by separate ducts near the last molar tooth.

Between the buccinator and the masseter muscles there is, in almost all subjects, a greater or less accumulation of fat. It is found beneath the zygoma especially, in the shape of large round masses, and may readily be turned out with the handle of the scal-

pel. It serves to fill up the zygomatic fossa, and being in itself so soft and delicate does not present the least obstacle to the free movements of the lower jaw. Its absorption in emaciated individuals occasions the sinking of the cheek.

We must next examine the facial artery and its branches.

70. *Facial artery.*—This artery passes over the ramus of the jaw at the anterior border of the masseter muscle. To this point it was traced in the dissection of the neck (see § 34). It now ascends very tortuously near the corner of the mouth and the ala of the nose, towards the inner angle of the eye, where, much diminished in size, it inosculates with a small branch of the ophthalmic artery. In the first part of this course the artery is covered only by the platysma; above the corner of the mouth it is crossed by a few fibres of the orbicularis oris and the zygomatic muscles, and still higher it is covered by some of the fibres of the levator labii superioris alæque nasi. It lies successively upon the buccinator, levator anguli oris and levator labii superioris muscles, and gives off the following branches.

a. Inferior coronary.—This artery comes off near the angle of the mouth, runs tortuously along the lower lip, between the mucous membrane and the orbicularis muscle, and inosculates with its fellow of the opposite side.

b. Superior coronary.—This proceeds along the upper lip close to the mucous membrane, and inosculates with its fellow; thus a complete arterial circle is formed round the mouth. These arteries can easily be felt in one's own person pulsating on the inner side of the lip, not far from the free border. From this circle numerous branches pass off to the papillæ of the lips, to the mucous membrane, and the labial glands. The superior coronary commonly gives off a small branch which ascends along the septum to the apex of the nose. It is commonly called the artery of the septum.

c. The *lateral artery of the nose,* a branch of considerable size, arises opposite the ala nasi, and ramifies upon the external surface of the nose.

d. The *angular artery,* which may be regarded as the termination of the facial, inosculates on the inner side of the tendo oculi with a branch of the ophthalmic.

The facial artery also supplies numerous unnamed branches to the muscles of the face, and inosculates with the transversalis faciei, infra-orbital and mental arteries.

The facial artery and its ramifications are surrounded by a minute plexus of nerves (nervi molles), which are scarcely visible to the naked eye. These nerves are derived from the superior cervical ganglion of the sympathetic, and are presumed to exert a powerful influence over the contraction and dilatation of the capillary vessels, and thus occasion those sudden changes in the countenance indicative of certain mental emotions. We refer to the every-day phenomena of blushing, and sudden paleness.

The *facial vein* differs from the artery in that it runs apart from it and nearly in a straight course. At the inner angle of the eye it is called the angular vein, and is situated close to the inner side of the tendo oculi, sometimes over, sometimes under the fibres of the orbicularis muscle. The vein descends beneath the zygomatic muscles, over the termination of the parotid duct, and at the anterior border of the masseter muscle passes over the ramus of the jaw, and commonly joins the internal jugular vein.

The facial vein may be considered as a continuation of a vein (the frontal) which descends perpendicularly over the forehead, and, after receiving the supra-orbital, takes the name of angular at the root of the nose. It communicates with the ophthalmic vein, receives the veins of the eyelids, the external parts of the nose, the coronary veins, and others from the muscles of the face. Near the angle of the mouth it is often much increased in size by the junction of a large vein which comes from a venous plexus deeply seated behind the superior maxillary bone.

71. *Arteria transversalis faciei.*—This artery arises from the external carotid, or the temporal in the substance of the parotid gland. It runs forwards over the upper part of the masseter muscle above the parotid duct, and is distributed to the glandula sociá parotidis, as well as the muscles and the skin of the face.

The transverse artery is seldom of large size, excepting when it supplies those parts which usually receive blood from the facial. It has been seen equal to the diameter of a goose-quill, furnishing the

coronary and the nasal arteries; the facial itself not being larger than a sewing thread.

We must now direct our attention to the parotid salivary gland.

72. *Parotid gland.*—This, the largest of the salivary glands, fills up the space between the ascending ramus of the jaw and the mastoid process of the temporal bone. Its boundaries may, with tolerable precision, be defined thus:—above, it reaches nearly to the root of the zygoma; below, it is in contact with the sterno-mastoid and digastric muscles; behind, it is limited by the meatus auditorius and the mastoid process; and in front, it lies along the ascending ramus of the jaw, and is prolonged for some distance over the masseter muscle. In the majority of subjects it is separated from the submaxillary gland by the stylo-maxillary ligament; but we should be aware that now and then the two glands are directly continuous with each other.

The superficial surface of the gland is flat, and covered by a strong layer of fascia, called by some anatomists the parotid aponeurosis; but this is merely a continuation of the cervical fascia. It requires, however, special notice, in so far as it not only envelopes the whole gland in a common sheath, but also sends down numerous partitions into its substance, forming, as it were, a frame-work for each individual lobe. The density of this sheath explains the pain caused by inflammation of the gland, the tardiness with which pus makes its way from the interior of the gland to the surface, and consequently the propriety of an early opening.

The deep surface of the gland is very irregular, and moulded upon all the subjacent parts, intruding itself into the interstices between them. Thus, it extends inwards between the neck of the jaw and the internal lateral ligament, surrounds the greater part of the styloid process and the muscles attached to it, and sometimes penetrates still deeper, so as to be in immediate contact with the internal carotid artery and the internal jugular vein.

That portion of the glandular substance which is prolonged over the masseter muscle is called the *glandula socia parotidis.* It is variable in size in different cases, and may sometimes be absent.

The greater part of it is situated above the parotid duct, into which it pours its secretion by one or two smaller ones.

The *duct* of the parotid gland (ductus Stenonis*), is very thick and strong, differing in this respect much from that of the submaxillary, which is less exposed to injury. It runs forwards over the masseter muscle, through the fat of the cheek, perforates the buccinator, and opens into the mouth opposite the second molar tooth of the upper jaw. Near its termination it is crossed by the zygomaticus major muscle and the facial vein. After perforating the buccinator the duct passes for a short distance between the muscle and the mucous membrane. Its orifice is small and contracted when compared with the diameter of the rest of the duct, which will admit a crowquill, and it is not easily found in the mouth, on account of a fold of mucous membrane.

Since it is important in operations about the face to know the precise direction of the duct, we may define it by a line drawn from the tip of the lobe of the ear to a point midway between the nose and the upper lip: of course the nose is presumed to be of the ordinary length.

a. Two or three small *absorbent glands* may generally be observed on the surface of the parotid. They are situated most frequently near the ear, but sometimes nearer the socia parotidis. A small gland also often lies over the root of the zygoma. There are no other superficial absorbent glands on the face; but two or more are deeply seated in the substance of the parotid gland. It will readily be conceived that a tumor formed by enlargement of glands so situated might be mistaken for disease of the parotid itself.

We must now cut into the substance of the parotid gland, in order to see the following important parts contained in its interior: 1. Nearest to the surface will be seen the primary branches of the facial nerve, which cross over the external carotid artery, and form by their mutual communications what is called the "pes anserinus," from its supposed resemblance to the foot of a goose. 2. Deeper still the external carotid appears; it gives off numerous small

* Nic. Steno, de glandulis oris, &c. Lugd. Bat. 1661.

branches to nourish the gland, and opposite the neck of the jaw divides into the temporal and inxternal maxillary arteries. 3. The corresponding veins, which unite to form the external jugular, lie superficial, but close to their arteries. 4. The temporo-auricular branch of the inferior maxillary nerve passes through the upper part of the gland near the meatus auditorius, and ascends over the root of the zygoma. 5. The two or three absorbent glands before alluded to; most commonly they are not far from the surface.

The easiest way of displaying the so-called "pes anserinus" is to find one of the larger branches of the portio dura, say one of the malar, on the face, and then by tracing this into the substance of the gland it will serve as a clue to the other branches. By removing, with the saw, a portion of the mastoid process, a good view may be obtained of the portio dura at its exit from the stylo-mastoid foramen.

We now purpose to examine the several nerves of the face:—first, the portio dura and its branches; and secondly, the branches of the fifth pair.

73. *Portio dura* or *facial nerve.*—This is the motor nerve of the face. It arises immediately below the "pons Varolii," from the lateral tract of the medulla oblongata. The nerve enters the meatus auditorius internus, traverses a canal called the "aqueductus Fallopii" in the petrous portion of the temporal bone, and finally emerges from the skull through the stylo-mastoid foramen. Its course and connexions in the temporal bone are somewhat complicated, and will be more properly investigated hereafter: at present we are only interested in what lies immediately before us.

Having, then, emerged from the styloid-mastoid foramen, the nerve enters the parotid gland, and soon divides into two primary branches, named, from their respective distribution, the temporo-facial and the cervico-facial. These, by their subsequent subdivisions and communications, form a network of nerves over the side of the face, temple, and upper part of the neck. We would especially direct attention to the general direction of these nerves; because, in removing tumors and performing other operations about the face, it is desirable to make the incisions parallel with the nerves, so as to spare as many of the larger branches as possible.

Close to the stylo-mastoid foramen the portio dura sends off its *posterior auricular* branch (see § 37), also a slender branch to the digastricus (posterior portion), and another to the stylo-hyoideus muscle.

A. The *temporo-facial* division crosses over the external carotid and the neck of the jaw, receives two or more communications from the temporo-auricular nerve (branch of the fifth), and subdivides into temporal, malar, and infra-orbital branches.

a. The *temporal* branches ascend over the zygoma, and supply the frontalis, the attrahens, and attollens aurem muscles, and communicate with filaments of the supra-orbital and temporo-auricular nerves.

b. The *malar* branches are numerous and large ; they cross the zygoma, supply the orbicularis oculi, and communicate with filaments of the lacrymal nerve.

c. The *infra-orbital* branches proceed forwards beneath the zygomatici over the masseter, and supply the elevators of the mouth and the muscles of the nose. One or more large filaments accompany the parotid duct, and supply the buccinator. Beneath the levator labii superioris we find a free communication with the infra-orbital branches of the second division of the fifth nerve.

B. The *cervico-facial* division, having been joined by filaments from the auriculo-parotidean (branch of cervical plexus), descends towards the angle of the jaw, and subdivides into supra and infra-maxillary branches.

a. The *supra-maxillary* advance over the masseter muscle and facial artery, and run under the depressor muscles of the lower lip, all of which they supply. Some of the filaments communicate with the mental branch of the dental nerve.

b. The *infra-maxillary* or cervical branches, one or more in number, were dissected with the neck (see § 6). They arch forwards below the ramus of the jaw, covered by the platysma, and communicate with the cervical plexus.

Respecting the function of the portio dura, it is necessary to remember that though at its origin it is purely a motor nerve, yet after leaving the stylo-mastoid foramen it becomes a compound

nerve, in consequence of the filaments which it receives from the temporo-auricular branch of the fifth.

We now turn our attention to the sensitive nerves of the face.

74. *Infra-orbital nerve.*—This is the terminal branch of the superior maxillary or second division of the fifth nerve. It emerges in company with its corresponding artery from the infra-orbital foramen, covered by the levator labii superioris muscle. The nerve immediately divides into several branches, of which some, ascending beneath the orbicularis muscle, supply all the component structures of the lower eyelid; others pass inwards to supply the structures on the outside of the nose; but by far the greater number descend into the upper lip, and eventually terminate in lashes of filaments, which run to the papillæ of the lip, and endow it with exquisite sensibility.

a. The *infra-orbital artery* is the terminal branch of the internal maxillary; it supplies the muscles and integument, and inosculates with branches of the facial.

75. *Mental nerve.*—This is a branch of the inferior maxillary or third division of the fifth nerve. It emerges from the mental foramen in the jaw, in a direction upwards and backwards, beneath the depressor labii inferioris. It soon divides into a number of branches which curve forwards; some of these supply the skin of the chin, but the greater number ascend to the integument and mucous membrane of the lower lip, in which they terminate after the manner described in the upper lip.

a. The *mental artery* is a branch of the inferior dental. It supplies the gums and the chin, and inosculates with the sub-mental and inferior coronary arteries.

The next subject we propose to examine is the anatomy of the muscles of mastication, and the course of the internal maxillary and temporal arteries.

MUSCLES OF MASTICATION. TEMPORAL AND INTERNAL MAXILLARY ARTERIES.

Immediately beneath the skin of the temple we find a layer of tough fibro-cellular tissue, which is continuous above with the

aponeurosis of the scalp, and below with the fascia covering the masseter muscle and the parotid gland. In this tissue are contained the superficial temporal vessels and nerves.

76. *Temporal artery.*—This is one of the terminal branches of the external carotid. Arising in the substance of the parotid gland near the neck of the jaw, it passes over the root of the zygoma close to the meatus auditorius, ascends for an inch and a half, more or less, upon the temporal fascia, and then divides into an anterior and a posterior branch. Above the zygoma it is superficial, being only covered by the little attrahens aurem muscle. It gives off the following branches:—

a. Several small branches to the parotid gland and the articulation of the jaw.

b. Commonly the *transversalis faciei* (see § 71).

c. The *middle temporal,* arising a little above the zygoma, perforates the temporal fascia, and inosculates in the substance of the temporal muscle with the deep temporal branches of the internal maxillary.

d. The *anterior auricular* ramify upon the front of the pinna and lobe of the ear, inosculating with the posterior auricular artery.

e. Of the two branches into which the temporal divides, the *anterior* is usually chosen for arteriotomy. It ascends tortuously towards the external angle of the frontal bone, from which it is distant generally about an inch. Its ramifications extend over the forehead, supplying the orbicularis and frontal muscles, and inosculate with the other arteries of the scalp. The *posterior* proceeds towards the back of the head, and inosculates freely with the occipital and posterior auricular arteries.

77. *Temporo-auricular nerve.*—This nerve, a branch of the third division of the fifth, supplies the temples and side of the head with common sensibility. After leaving the parotid gland it will be found close to the posterior border of the temporal artery. Its several ramifications correspond with those of the temporal artery, upon which they are placed superficially.

a. Near the condyle of the jaw the temporo-auricular nerve sends two or more branches to the upper division of the facial

nerve, thus endowing it with common sensibility (see § 73, A). Above the zygoma it gives off a few slender filaments (auricular) to the pinna of the ear: these generally proceed from that branch which accompanies the posterior temporal artery.

In the subcutaneous tissue of the temple we also look for the temporal branches (see § 73, A, *a*) of the facial nerve, which ascend to supply the frontal, the attrahens, and attollens aurem muscles.

In the proper temporal fascia, about an inch or more above the zygoma, we may observe one or two small openings which transmit cutaneous filaments from the first or the orbital division of the fifth nerve. Some of these join the filaments of the facial nerve.

The little muscles which move the ear will be described with the dissection of the scalp.

Divide the parotid duct, and turn it back with the anterior part of the gland and the branches of the portio dura from the surface of the masseter. This muscle should be carefully cleaned. It will now be observed that at the posterior border of the masseter the parotid gland lies in immediate contact with, and in fact covers, the condyle and neck of the jaw. In some few instances a portion of glandular substance penetrates behind the masseter and comes in contact with the external pterygoid muscle.

78. *Masseter muscle.*—This strong quadrilateral muscle arises by aponeurotic fibres from the lower border of the zygomatic arch, and is inserted into the outer surface of the angle and ascending ramus of the jaw. We may distinguish, however, a superficial and a deep layer of fibres which cross each other somewhat like the letter X. The superficial fibres, constituting indeed the principal part of the muscle, arise from the anterior two-thirds of the zygoma by a very strong tendon which occupies the outer surface and the front border of the muscle, and sends aponeurotic partitions into its substance. The fibres descend with a slight inclination backwards, and are inserted into the angle and adjoining part of the ramus of the jaw. The deeper layer of fibres arise from the posterior part of the zygoma, descend with an inclination forwards, and are inserted into the upper half of the ramus. Besides these we shall presently find that a few fibres, taking origin from the

inner surface of the zygoma, are inserted into the coronoid process and the tendon of the temporal muscle. Its *action* is to close the jaw with great force.

Reflect the masseter from its origin by dissecting close to the zygoma. Observe the respective direction of the superficial and deep strata of muscular fibres; also the tendinous partitions which so greatly augment the power of the muscle by increasing its extent of origin. The masseteric nerve and artery will be found entering the under surface of the muscle through the sigmoid notch of the jaw; the artery is a branch of the internal maxillary, the nerve proceeds from the motor division of the inferior maxillary.

We should now examine the temporal aponeurosis, and the temporal muscle.

79. The *temporal aponeurosis* is the name given to the strong shining membrane which arises from the upper border of the zygomatic arch, and is inserted into the curved line observable on the side of the skull bounding the so-called temporal fossa. It not only completes the case in which the temporal muscle is contained, but also furnishes additional surface for the attachment of its fibres. It increases in thickness from above downwards, and near the zygoma divides into two layers, which are attached respectively the one to the outer edge, the other to the inner surface of the arch. By cutting through the more superficial of these layers we shall find that a small quantity of fat intervenes between them, and very often there is a considerable branch of the temporal artery. The density of this aponeurosis explains the reason why abscesses in the temporal fossa so rarely point outwards, but make their way beneath the zygoma, and burst into the mouth.

Divide the temporal aponeurosis in a longitudinal direction, and reflect it from the temporal muscle. Notice that the aponeurosis gives origin to muscular fibre only near its attachment to the temporal ridge; that it is separated from the muscle near the zygoma by a greater or a less amount of fat. The absorption of this fat, as well as the wasting of the muscle itself, occasions the falling in of the temple in the aged and those emaciated by disease.

a. The *temporal muscle* arises from the whole surface of the temporal fossa down to the ridge observable on the great wing of

the sphenoid bone, and also from a certain part of the temporal aponeurosis. The fibres converging from this wide extent of origin pass under the zygomatic arch, and terminate upon a tendon which is inserted into the anterior border and the inner surface of the coronoid process of the jaw. The outer surface of the tendon is partially concealed by the insertion of those fibres which come from the temporal aponeurosis; but if these be removed it will then be apparent how admirably this tendon is adapted to the muscle, radiating into its substance, as it were, like the ribs of a fan, in order to receive the insertion of its converging bundles. Thus the whole force of the muscle is collected into one focus.

The power possessed by the muscles which close the jaw is quite astonishing. Haller* mentions several instances of it. One Thomas Topham lifted with his lower jaw a table six feet in length with 50lbs. attached to its lower end. It is not uncommon to see individuals who can balance on their chins a ladder so heavy that they can hardly lift it.

80. Pursuing, now, the dissection with a view to expose the internal maxillary artery, we must first remove with Hey's saw the zygomatic arch; this will expose the coronoid process of the jaw, the insertion of the temporal muscle, and a considerable quantity of loose fat and cellular tissue which surround it. Next saw through the coronoid process in a direction downwards and forwards, so as to include nearly the whole insertion of the temporal muscle; and then turn it upwards with the muscle without injuring the subjacent vessels and nerves. The next step is to saw through the neck of the jaw about five-eighths of an inch below the condyle. Lastly, remove the remaining part of the neck close to the ramus of the jaw. By this mode of proceeding the region called *pterygo-maxillary* will be fairly exposed; but a careful dissection is required to display the following important parts contained in it:—

a. The greater part of the space is occupied by two thick and strong muscles of mastication—the pterygoid, so named on account of their attachment to the pterygoid process of the sphenoid bone.

* Elem. Phys. lib. xi. sect. 2, § 26.

One of them (external pterygoid) passes horizontally outwards and backwards towards the condyle of the jaw; the other (internal pterygoid) descends backwards to the angle. Below the inferior border of the external pterygoid muscle two large nerves (the gustatory and the dental branch of the inferior maxillary) are observed crossing the fibres of the internal pterygoid, At the same time a satisfactory view is presented of the origin of the buccinator, (see § 69) of the buccal fascia, and the molar glands. It is through the space now before us that the internal maxillary artery will be seen pursuing a very tortuous course either between the two pterygoid muscles or external to both. But we will first examine the muscles.

81. *External pterygoid.*—This muscle consists of two portions, an upper and a lower, more or less distinct, and commonly separated near their origin by the internal maxillary artery. The lower portion, by far the larger of the two, arises from the outer surface of the external pterygoid plate of the sphenoid bone; the upper from the great wing of the sphenoid bone, below its crest. The fibres of the muscle pass horizontally outwards and backwards, slightly converging, and are most of them inserted into a depression observable on the front surface of the neck of the jaw immediately below the condyle. Some few, however, of the fibres are directly implanted along the front border of the inter-articular fibro-cartilage, in order that it may never be separated from the condyle during the several movements of the jaw.

a. The *internal pterygoid* arises from the fossa between the pterygoid plates of the sphenoid bone, but chiefly from the inner surface of the external plate; it also arises from both sides of the tuberosity of the palate bone, which respectively assist in forming the external and internal pterygoid fossæ. The fibres descend outwards and backwards, and are inserted into a rough surface on the inner side of the angle of the jaw.

The pterygoid muscles are very similar to the masseter in structure; that is to say, we find that, both at their origin and insertion, a number of tendinous septa are interposed between the muscular fibres, manifestly for the purpose of affording an increase

of surface for their attachment, and therefore giving the muscle greater power.

Action.—The use of the pterygoid muscles is to produce that rotatory movement of the lower jaw so essential to the proper mastication of the food. Consequently we find them enormously developed in all ruminants, and comparatively feeble in carnivorous animals.

We must now carefully disarticulate the condyle of the jaw with its fibro-cartilage from the glenoid fossa, and turn it forwards along with the external pterygoid muscle, so that the condyle can be replaced if desirable. A very little dissection will bring into view the internal maxillary artery.

82. *Internal maxillary artery.*—This is one of the terminal branches of the external carotid. It arises in the substance of the parotid gland, and proceeds horizontally forwards between the neck of the jaw and the so-called internal lateral ligament; it then continues its course, in some cases above, in others beneath the external pterygoid muscle towards the back part (tuberosity) of the superior maxillary bone, and lastly, curving upwards between the two origins of the external pterygoid muscle, it sinks into the spheno-maxillary, fossa and terminates by dividing into several branches.

To facilitate the understanding of the course of this artery we divide it into three stages, each of which gives off appropriate branches. The first stage comprises the extent of the artery behind the neck of the jaw; the second includes the middle portion in connexion with the pterygoid muscles; and the third, the remainder in the spheno-maxillary fossa.

A. In the first part of its course the internal maxillary gives off:—

A. The *tympanic* artery, which passes through the "fissura Glaseri" to the tympanum. This branch is apt to vary as to its origin, and is often absent.

b. The *middle meningeal* artery ascends between the two roots of the temporo-auricular nerve through the foramen in the spinous process of the sphenoid bone, and thus enters the cranium, where

it ramifies between the dura mater and the bones. This artery sometimes furnishes a supplemental meningeal, which passes into the skull through the foramen ovale.

e. The *inferior dental* artery arises opposite the preceding, and descends behind the neck of the jaw to the dental foramen, which it enters in company with the dental nerve. It then proceeds along the canal excavated in the diploe of the jaw as far as the symphysis, where it minutely inosculates with its fellow. In this canal, which runs beneath the roots of all the teeth, the artery gives off branches which ascend through the minute apertures in the fangs, and ramify upon the pulp in their interior. Opposite the foramen mentale there arises the mental branch already described, § 75 *a*. Before entering the lower jaw the dental artery sometimes furnishes a small branch which accompanies the nerve proceeding to the mylo-hyoid muscle (see § 21, *a*).

B. In the middle of its course, *i. e.* in connexion with the pterygoid muscles, the internal maxillary gives off a series of branches to the muscles of mastication, namely,—

a. The *deep temporal* arteries, commonly two in number, ascend to supply the temporal muscle, ramifying close to the bone. They inosculate with the superficial temporal arteries, and often send small branches through the malar bone into the orbit, inosculating with the lacrymal.

b. The *masseteric* branch passes through the sigmoid notch of the jaw to the under surface of the masseter.

c. The *pterygoid* branches are irregular in number, origin, and size.

d. The *buccal* branch proceeds forwards with the buccal nerve to the buccinator.

C. In the last part of its course, *i. e.* in the spheno-maxillary fossa, the internal maxillary gives off the following :—

a. The *superior maxillary* branch runs tortuously along the back part of the superior maxillary bone, and sends small arteries which pass through the foramina in the bone to supply the pulps of the molar and bicuspid teeth. It also supplies the gums and the mucous membrane of the antrum.

b. The *infra-orbital* branch passes through the spheno-maxillary

fissure, and then proceeds forwards along a groove or canal in the floor of the orbit in company with the superior maxillary nerve, and emerges upon the face at the infra-orbital foramen (see § 74 *a*). While contained in the canal this artery sends branches downwards to supply the front teeth; and others which ascend to the muscles of the orbit.

c. The *descending palatine,* a branch of considerable size, runs perpendicularly through the posterior palatine canal with the palatine nerve, and then passes forwards along the hard palate, in which it is ultimately lost. It supplies the gums, the glands, and mucous membrane of this part, and also furnishes branches to the soft palate.

d. The *vidian,* an insignificant branch, runs backwards through the canal at the root of the pterygoid processes with the vidian nerve, and is lost upon the Eustachian tube.

e. The *nasal* branch enters the nose through the spheno-palatine foramen in company with the nasal nerve from Meckel's (spheno-palatine) ganglion, and ramifies extensively upon the spongy bones and the septum narium, supplying the mucous membrane.

f. The *internal maxillary vein* is formed by the several veins corresponding to the branches of the artery. It joins the temporal vein in the substance of the parotid gland.

Having now completed the anatomy of the muscles concerned in mastication, and the blood-vessels which nourish them, we proceed next to examine the nerves by which they are supplied.

83. *Inferior maxillary nerve and branches.*—This great nerve is the largest of the three divisions of the fifth cerebral nerve. It differs from the other two divisions, *i. e.* the ophthalmic and the superior maxillary, in that it contains motor as well as sensitive filaments; the motor being furnished by the small non-ganglionic root of the fifth nerve. Thus much of its physiology it is necessary to know, in order to understand the extensive distribution of the nerve, for we shall presently find that the motor portion supplies all the muscles concerned in the movements of the lower jaw;*

* Excepting the genio-hyoidei muscles, which are supplied by the hypoglossal nerve.

whilst the other portion confers only common sensibility upon the parts to which it is distributed.

The nerve, then, composed as above stated of sensitive and motor filaments, emerges from the skull through the foramen ovale as a single thick trunk, under the name of the inferior maxillary. It lies directly external to the Eustachian tube, from which it is separated by the so-called pterygo-spinous ligament; and it is covered by the external pterygoid muscle, which should be turned on one side to expose it. Immediately after its exit from the skull the nerve divides into its several branches; some, destined for the muscles, contain motor as well as sensitive filaments; others are purely sensitive, namely the temporo-auricular, the inferior dental, and the gustatory. Let us first consider the muscular branches.

A. *a.* Branches, two or more, to the *temporal* muscle. These pass outwards close to the bone, and ascend in company with the temporal arteries into the substance of the muscle. A few slender filaments perforating the muscle and its aponeurosis, communicate with filaments of the superficial temporal, the facial, and the lacrymal nerve.

b. The branch to the *masseter* muscle passes outwards above the external pterygoid muscle, and then through the sigmoid notch of the jaw (§ 78).

c. Branch to the *internal pterygoid* and *tensor palati* muscles. —This nerve is rather difficult to find. It proceeds from the inner side of the main trunk, and then descends between the internal pterygoid and the tensor palati muscles, supplying both of them.

d. The *buccal* branch passes forwards either above or between the fibres of the external pterygoid, to the outer surface of the buccinator muscle, where we find it spreading out into a number of diverging filaments, which supply the skin, the mucous membrane and glands of the cheek, and also the muscle itself, with common sensibility. The motor power of the buccinator, be it remembered, is derived from the facial (see § 73, A, *c*). This is proved not only by careful dissection, but also by the fact that it loses its power of contraction when the facial nerve is paralysed;

and that it retains its power of contraction when the muscles of mastication are paralysed.

It may be observed that the buccal nerve, in its passage through the external pterygoid muscle, occasionally sends a branch to it, or perhaps one to the temporal muscle. Careful examination makes it probable that the filaments constituting these branches are derived from the motor root of the fifth nerve.

B. The branches, purely sensitive, of the fifth nerve are the temporo-auricular, the gustatory, and the dental.

a. The *temporo-auricular* branch has usually two roots which embrace the middle meningeal artery just before it enters the skull (see § 82, A, *b*). The nerve passes outwards behind the neck of the jaw, covered by the parotid gland, then ascends over the root of the zygoma with the superficial temporal artery, and finally ramifies in company with this artery upon the temple and side of the head, supplying the integument (see § 76). While passing behind the condyle it sends one or two delicate filaments to the articulation of the jaw, and also some which pierce the cartilage of the ear, and supply the skin lining the meatus auditorius. It has already been stated more than once that branches proceed from this nerve to the upper division of the facial, and thus endow it with the power of common sensibility.

b. The *inferior dental* branch descends between the ramus of the jaw and the so-called internal lateral ligament of the jaw to the dental foramen, which it enters in company with the dental artery. It then runs in the canal prepared for it in the cancellous texture of the jaw immediately below the fangs of all the teeth. It furnishes a series of filaments which ascend through the canals in the fangs of the teeth to the vascular and sensitive pulp in their interior. Opposite the foramen mentale the mental branch is given off (see § 75). It is interesting to observe that the same nerve which supplies the teeth supplies the corresponding gums; hence the sympathy existing between these parts.

c. Mylo-hyoid branch.—This nerve, though apparently originating from the dental, and commonly so described, is in point of fact derived from the motor root of the fifth, and may with careful dissection be traced to it. It is true that for a short distance it

would seem a part of the dental, and indeed in most cases receives a filament from it, but this does not make it the less an independent nerve, and we find it leaving the dental near the foramen in the jaw, and running in a groove on the inner side of the ramus to the lower surface of the mylo-hyoid, which muscle, together with the anterior portion of the digastricus, it supplies (see § 21, *a*).

d. The *gustatory* or *lingual* branch descends forwards first between the ramus of the jaw and the internal pterygoid muscle, and then for a short distance between the jaw and the superior constrictor of the pharynx. In this latter situation it lies close to the mucous membrane of the mouth nearly behind the last molar tooth of the lower jaw. The subsequent course of the nerve between the mylo-hyoid and hyo-glossus muscle, as well as its branches, have been described, § 28.

The upper part of the gustatory nerve is joined by the corda tympani, (a branch of the portio dura) which emerges from the fissura Glasseri, and eventually runs to the submaxillary ganglion.

84. *Internal lateral ligament of the jaw.*—We have now a good opportunity of examining this so-called ligament. By some anatomists it is not recognised as a ligament, and with some reason, seeing that it is placed at such a distance from the joint. But this is a matter of no consequence. Our concern is to know that it is attached on the one hand to the spinous process of the sphenoid bone, that it expands considerably, and is attached on the other to the ramus of the jaw on the inner side of the foramen dentale. Interposed between it and the neck of the jaw we find the internal maxillary artery and vein, the temporo-auricular nerve, the middle meningeal artery, the dental nerve and artery, and a portion of the parotid gland.

Divide the internal maxillary artery, and dissect out carefully the parotid gland to see its deep connexions. Observe how it almost surrounds the styloid process and the muscles therefrom arising; notice also that portion which, in most subjects at least, penetrates between the styloid process and the internal lateral ligament of the jaw towards the internal carotid artery. After thus reviewing the deep and intricate connexions of this gland one can-

not help reflecting that to remove it completely during life seems almost if not quite impracticable. If this be true even in the normal condition of parts, what must it be when they are enlarged by disease? John Bell, however, relates a case in which he was induced to attempt the extirpation of a diseased parotid.* Other surgeons, too, of modern date have attempted the same thing. It is probable that an enlargement of one of the absorbent glands in the substance of the parotid might have been mistaken for disease of the parotid itself.†

By drawing forwards with hooks the angle of the jaw, a very little dissection is required to obtain a good view of two slender muscles, the stylo-glossus and stylo-pharyngeus, and also of the glosso-pharyngeal nerve: all of which, it will be observed, intervene between the external and internal carotid arteries. The course and relations of the internal carotid artery are likewise fairly displayed. These several objects we shall now proceed to examine.

85. *Stylo-glossus* muscle.—This slender muscle arises from the styloid process near the apex, and sometimes also from the so-called stylo-maxillary ligament. It passes forwards and expands upon the side of the tongue external to the hyo-glossus muscle. Some of its fibres run on with the lingualis muscle to the apex of the tongue. Its *action* is to retract the tongue.

86. *Stylo-pharyngeus* muscle.—This muscle, more deeply seated than the former, arises by tendinous fibres from the styloid process near the base. It then descends, inwards, to the side of the pharynx, and passes between the superior and middle constrictor muscle. We shall presently find, however, that it gradually expands and terminates upon the posterior border of the thyroid cartilage. Its *action* is to assist in raising the pharynx in the act of deglutition.

a. Between the stylo-glossus and stylo-pharyngeus muscle, and nearly parallel with both, will be seen the stylo-hyoid ligament.

* J. Bell's Principles of Surgery, vol. iii. p. 262.

† On this subject see Allan Burns, Surgical Anatomy of the Head and Neck.

It extends from the apex of the styloid process downwards and inwards to the lesser cornu of the hyoid bone. It is often more or less ossified.

b. The ascending palatine artery, a branch of the external maxillary, (see § 34, *a*) will probably be seen running up between the stylo-glossus and stylo-pharyngeus, and subsequently dividing into numerous irregular branches which supply these muscles, the palate, the side of the pharynx, and the tonsils.

87. *Glosso-pharyngeal nerve.*—The best guide to this nerve is the lower border of the stylo-pharyngeus muscle. It is classed as one of the divisions of the eighth pair. It arises by four or five filaments from the restiform tract of the medulla oblongata, near the pons Varolii, and is therefore at its origin purely a sensitive or afferent nerve. Leaving the skull through the foramen lacerum posterius, it descends very obliquely over the internal carotid artery, and then proceeds along the lower border of the stylo-pharyngeus muscle. But now it curves forwards over the stylo-pharyngeus, and disappears beneath the hyo-glossus, where it divides into its terminal branches for the supply of the mucous membrane of the pharynx, the back of the tongue, and the tonsils.

a. It was stated that at its origin the glosso-pharyngeal is purely a sensitive nerve. But soon after its exit from the skull it receives communications from the facial and the nervus accessorius, so that it soon becomes a compound nerve, *i. e.* composed of both sensitive and motor filaments. Moreover, at the base of the skull it is provided with a ganglion, called, from its discoverer, the ganglion of Andersch. The minute branches given off by this ganglion will be noticed in their proper place; at present we are more concerned with what is called the pharyngeal plexus of nerves.

88. *Pharyngeal plexus.*—By the side of the pharynx, near its middle constrictor muscle, we find an intricate interlacement of nerves, constituting the plexus which presides over the act of deglutition. Its dissection requires much time and care, and a pharynx exclusively prepared for the purpose. The nerves which enter into its composition are derived from many sources, namely, the glosso-pharyngeal, the pneumogastric (especially its superior laryngeal

branch), the spinal accessory, and the sympathetic. Consequently it possesses nerves of three different kinds—ganglionic, sensitive, and motor. Its minute ramifications supply the pharynx, the back of the tongue, and tonsils.

89. Course and relations of the internal carotid artery.—The internal carotid artery, proceeding from the division of the common carotid, ascends nearly perpendicularly to the base of the skull, by the side of the pharynx and close to the transverse processes of the three upper cervical vertebræ. It then enters the skull through the tortuous canal in the petrous portion of the temporal bone, takes a winding course by the side of the "sella tursica," and terminates in branches which supply the orbit and a part of the brain. In the first part of its course, where it is situated immediately outside the external carotid, that is, near the inner border of the sterno-mastoid muscle, the artery is comparatively superficial, being covered only by the platysma and the cervical fascia. But it very soon becomes deeply seated beneath the parotid gland, and therefore beneath the external carotid. In its upward course it is crossed successively by the hypoglossal nerve and the occipital artery; still higher, and under cover of the parotid gland, it is crossed obliquely by the styloid process, by the stylo-glossus and pharyngeus muscle, by the glosso-pharyngeal nerve, and the stylo-hyoid ligament, all of which intervene between it and the external carotid artery.

Along the outer side of the artery lies the internal jugular vein; and behind the artery we find the pneumogastric nerve and the superior cervical ganglion of the sympathetic. The rectus capitis anticus major muscle separates it from the cervical vertebræ. But after all, the most important relation of the artery in a surgical point of view is this; that it ascends close to the side of the pharynx and tonsils. In opening an abscess, therefore, formed in the tonsils, or at the back of the pharynx, the surgeon should be careful to introduce the instrument with its point directed rather inwards towards the mesial line; and this caution should be the more scrupulously observed, because, in some subjects, elderly ones especially, more rarely in the young, the internal carotid makes a

singular sigmoid curve, or even a complete curl upon itself, in its ascent near the pharynx. In such cases the least deviation of the instrument in an outward direction would almost surely injure the vessel; an occurrence of which instances have been recorded.

The internal carotid does not give off any branches in the cervical portion of its course.

90. *Ascending pharyngeal artery.*—We have now a clear view of the course of this small vessel. Arising from the angle formed by the division of the common carotid, or perhaps from the commencement of the external carotid, it ascends by the side of the pharynx, towards the base of the skull. It gives off several branches which supply the upper part of the pharynx, the tonsils, the Eustachian tube, and the muscles in front of the spine. One or more slender branches, called meningeal, enter the skull, either in company with the jugular vein or through the foramen lacerum medium, and supply the dura mater.

91. *Pneumo-gastric nerve.*—This nerve can at present be seen only in the cervical portion of its course. It is usually described as one of the three divisions of the eighth pair of cerebral nerves. It arises from the so-called restiform tract of the medulla oblongata by a series of filaments immediately below and on the same plane with those of the glosso-pharyngeal nerve. It passes out of the skull in close company with the nervus accessorius, through the foramen jugulare. Very soon a ganglion is observed in its substance analogous to the posterior or sensitive roots of all the spinal nerves, and it is joined by two considerable branches from its companion the nervus accessorius.

Thus, the pneumo-gastric, probably only sensitive at its origin, becomes in consequence of this reinforcement a compound nerve, and in all respects analogous to a spinal nerve. So much, by way of explaining the various distribution and function of this nerve.

Leaving the skull, then, at the foramen jugulare, it descends perpendicularly in front of the cervical vertebræ, lying successively upon the rectus capitis anticus major and the longus colli muscle. In the upper part of the neck it is situated behind the internal carotid artery, but in the lower, as already stated, between and

behind the common carotid and the internal jugular vein. Finally it enters the chest, on the right side crossing the subclavian artery nearly at a right angle ; on the left running nearly parallel with it.

A. The anatomy of the ganglion formed upon the pneumogastric nerve in the foramen jugulare will be described hereafter. Our present concern is with the cervical portion of the nerve only. The first thing to be observed is, that the nerve after leaving the skull swells out considerably, and becomes more of a reddish-grey colour; so that apparently another ganglion is formed in its substance. The ganglionic enlargement occupies more or less of the nerve in different instances, generally about an inch. It is very intimately united to the hypoglossal nerve, from which it receives two or more filaments. It also receives filaments from the first and second spinal nerves, and from the superior cervical ganglion of the sympathetic. There proceed from it the following branches :—

a. Pharyngeal.—Two or more descend either in front of or behind the internal carotid to the pharyngeal plexus (see § 88).

b. Superior laryngeal.—This descends behind the external carotid to the interval between the os-hyoides and the thyroid cartilage, where it enters the larynx (see § 32).

c. Cardiac.—These long nerves, two or more, descend in the loose cellular tissue behind the sheath of the carotid to the cardiac plexus. They vary much as to the situation of their origin,—proceeding from the main trunk, sometimes higher, sometimes lower, in the neck. Hence some anatomists describe upper and lower cardiac filaments. But this is hardly necessary. On their passage to the heart they cross the arteria innominata on the right, and the arch of the aorta on the left side.

92. *Sympathetic nerve.*—We now pass on to examine the cervical ganglia of the sympathetic system of nerves. Speaking in general terms of this system, it may be stated that it consists of a series of ganglia arranged on either side of the spine, from the first cervical to the last sacral vertebra. The ganglia of the same side are connected, each with the other, by intermediate nerves, so as to form a continuous cord : this constitutes what is commonly called the trunk of the sympathetic system. On the one hand it is con-

nected with all the spinal nerves; on the other it furnishes numerous branches to the organs in the neck, the chest, the abdomen, and the pelvis. Its upper or cephalic extremity penetrates into the interior of the cranium through the carotid canal, surrounds the internal carotid artery, communicates with several cranial nerves, and eventually joins its fellow of the opposite side upon the anterior communicating artery. Its sacral extremity also joins its fellow by means of a little "ganglion impar," situated in the mesial line.

In the cervical portion of the sympathetic there are commonly three ganglia, named, from their position, superior, middle, and inferior. Each of these we shall successively describe in terms as general as possible, for the reason that their ramifications are subject to great variety.

A. *Superior cervical ganglion.*—This, the largest of the three, is situated near the base of the skull, upon the rectus capitis anticus major muscle, and behind the internal carotid artery. It is of a reddish-grey colour like other ganglia, of an elongated oval shape, varying in length from one to two inches. It may facilitate the description of its several branches if we divide them into—1st, those which, according to the present state of our knowledge, are presumed to connect it with other nerves; and 2dly, those which originate from it.

It is then connected by branches as follows :—

a. With each of the four upper spinal nerves.

b. With the hypoglossal, pneumogastric, and glosso-pharyngeal nerves.

c. With the third and the sixth cerebral nerve (in the cavernous sinus).

d. With the several ganglia of the sympathetic system about the head and neck; namely, the ophthalmic, spheno-palatine, otic, and submaxillary.

The branches which it distributes are—

e. Nerves to the heart.—One or more descend behind the sheath of the carotid, and entering the chest, join the cardiac plexus.

f. Nerves to the pharynx.—These join the pharyngeal plexus.

g. Nerves to the blood-vessels.—These nerves, named on account

of their delicacy of structure "nervi molles," ramify around the external carotid artery and its branches.

B. *Middle cervical ganglion.*—This is usually in size something less than a flattened barley-corn. It is situated behind the carotid sheath, about the fifth or sixth cervical vertebra, near the inferior thyroid artery. It receives branches from the fifth and sixth spinal nerves, and gives off—

a. Branches to the thyroid body.—These accompany the inferior thyroid artery.

b. Branch to the heart.—This usually descends in front of the subclavian artery into the chest. It often communicates with the recurrent laryngeal nerve.

This ganglion, called by Soemmering "ganglion thyroideum," is, according to our observation, more frequently absent than present. In the cases where it is absent, the preceding nerves are supplied by the sympathetic cord connecting the superior and inferior ganglia.

C. *Inferior cervical ganglion.*—This is commonly semilunar in form, and is situated in the interval between the transverse process of the seventh cervical vertebra and the first rib, immediately behind the vertebral artery. It receives branches from the seventh and eighth spinal nerves, and others which, descending from the fourth, fifth, and sixth, through the foramina in the transverse processes of the vertebræ, form a plexus around the vertebral artery.

The only branch which it gives off is—

a. Inferior cardiac nerve.—This descends, communicating often with the recurrent laryngeal, and joins the deep cardiac plexus behind the arch of the aorta.

DISSECTION OF THE CHEST.

93. Before we proceed to examine the several organs contained in the chest, we ought to have some knowledge of the frame-work of this cavity. The true ribs with their cartilages describe a series of arcs, successively increasing in length from above downwards, so as to form, with the spine and the sternum, a barrel of a somewhat

conical shape, and a little broader in the lateral than in the antero-posterior direction. The lower aperture or base of the cavity is closed by a large muscle called the diaphragm, because it forms a partition between the chest and the abdomen, permitting only the passage of certain canals between them. The partition is not flat, but arched upwards, so that it constitutes a vaulted floor for the chest, and moreover by its capability of alternately contracting and dilating can thus increase or diminish the capaciousness of this cavity. The spaces between the ribs are filled by the intercostal muscles. In each intercostal space there are two layers of these muscles, arranged so as to cross each like the branches of the letter X. The fibres of the outer layer run obliquely from above downwards, and from behind forwards; those of the inner layer in just the reverse direction.

The upper aperture of the chest gives passage to the trachea, the œsophagus, the great vessels of the neck and the arms, and also to certain muscles and nerves; the interspaces between these parts being occupied by a dense fibro-cellular tissue.

Such, in outline, is the frame-work of the cavity, closed on all sides, which contains the heart and lungs. We may observe that its walls are made up of different structures, bone, cartilage, and muscle, so admirably disposed as to fulfil two important conditions. By their solidity and elasticity they protect the important organs contained in them, and by their alternate dilatation and contraction they act as mechanical powers of respiration. For they can increase the cavity of the chest in three directions: in height, by the descent of the diaphragm; in width, by the turning outwards of the ribs; and in depth, by the elevation of the sternum.

Generally speaking, the right side of the chest is a little larger than the left. Out of ninety-two individuals, of the same sex and good constitution, seventy-one had the right side larger than the left; eleven, the left larger than the right; and ten had both sides of equal dimensions. The maximum of the difference in favour of the right side was fifteen lines. The measurements were made from the spine round the circumference of the side of the chest, on a plane with the nipple, to the middle of the sternum.

The chest of the female differs from that of the male in the follow-

ing points :—Its general capacity is less ; the sternum is shorter ; the upper opening is larger in proportion to the lower ; and the upper ribs are more moveable, and therefore permit a greater enlargement of the chest at its upper part, in adaptation to the condition of the abdomen during pregnancy.

94. In the dissection of the interior of the chest it is considered most advantageous to examine the parts in the following order :—1st. The so-called anterior mediastinum and its contents ; 2dly. The course and relations of the great vessels at the upper part of the chest ; 3dly. The relative position of the heart and lungs in a general way ; 4thly. The contents of the so-called posterior mediastinum with the intercostal muscles, vessels, and nerves ; lastly, The anatomy of the heart and the lungs.

In the first place, then, we must make a kind of window, so to speak, into the chest, by removing the greater part of the sternum and the cartilages of nearly all the true ribs. Saw transversely through the sternum about a quarter of an inch below the clavicle, and again on a level with the cartilage of the sixth rib. We leave this small portion of the upper part of the sternum as a valuable landmark, though it obstruct to a certain extent the view of the subjacent vessels. Cut through the cartilages of all the true ribs, excepting the first and the last, close to the bone of the rib, and then raise the sternum with its attached cartilages from below upwards ; in doing this, great care must be taken not to wound the pleura which is closely connected with the cartilages. On the one side it is desirable to remove the internal mammary artery, on the other to leave it in situ.

On the under surface of the sternum and cartilages of the ribs thus removed, there is a muscle, variable as to the extent of its origin and development, named triangularis sterni. It must be observed, however, that a certain portion of the muscle is unavoidably injured in this mode of exposing it.

95. *Triangularis sterni.*—This muscle arises from the posterior surface of the ensiform cartilage and the lower part of the sternum. Its fibres ascend outwards, and divide into four or five digitations which are inserted into a variable number of the cartilages of the true ribs, from the second inclusive to the sixth. The lower fibres

are nearly horizontal, the rest successively increase in obliquity. Its *action* is to depress the costal cartilages; it is therefore a muscle of expiration.

96. *Internal mammary artery.*—Trace the further course and branches of this artery, partially described at § 47. It runs perpendicularly about half an inch from the sternum, behind the cartilages of the ribs, and entering the wall of the abdomen as a small artery, continues its descent behind the rectus abdominis muscle, and finally inosculates with the epigastric (a branch of the external iliac). Its branches are as follows:—

a. The *arteria comes nervi phrenici.*—A very slender artery, sometimes absent, accompanies the phrenic nerve to the diaphragm.

b. Mediastinal and thymic.—These branches supply the cellular tissue of the anterior mediastinum, the pericardium, and the triangularis sterni muscle. The *thymic* are only visible in early childhood, gradually disappearing with the gland they supply.

c. Intercostal.—One at least, and often two, for each intercostal space. If there be one only, it runs along the lower border of the corresponding rib; if there be a second, it proceeds along the upper border of the rib: they inosculate with the intercostal arteries from the aorta.

d. Perforating arteries, which pass through the intercostal spaces, and supply the pectoral muscle and integument of the chest. In the female they are often of large size, for the supply of the mammary gland (see Arm, § 3).

e. The *intercosto-phrenic* branch, turning outwards behind the cartilages of the false ribs, passes through the diaphragm commonly about the ninth rib, and terminates near the last intercostal space. It sends off small arteries to the diaphragm, and to the sixth, seventh, and sometimes the eighth intercostal spaces.

97. *Absorbent glands.*—There are several of these in the neighbourhood of the internal mammary artery. They receive the absorbent vessels from the inner portion of the mammary gland, from the upper part of the diaphragm, and the wall of the abdomen. In scirrhus disease of the inner portion of the mamma, it happens sometimes that these glands become enlarged, without any enlargement of those in the axilla.

98. *Mediastinum.*—The chest is divided into two lateral chambers, containing the right and the left lung. Each of these is lined by a serous membrane called the pleura, which, being reflected over the lung, forms a completely closed sac on either side. The opposite sides of these two sacs constitute a sort of median partition between the two halves of the chest extending from the sternum to the spine. But the sides of the two sacs are nowhere in contact, being separated by the thymus gland in front (at least in early life) by the heart and its pericardium in the middle, and by the aorta, œsophagus, &c. behind. This septum is commonly called the mediastinum, and the interval between its layers, occupied by the heart, &c., is called the "cavitas mediastini."

That portion of the mediastinum formed by the divergence of the pleura on either side from the sternum to the pericardium, is called by some anatomists the anterior mediastinum. A corresponding space, situated between the pericardium and the spine, is called the posterior mediastinum.

The so-called anterior mediastinum, or space left between the diverging layers of pleura, lies immediately behind the sternum in a line not precisely longitudinal, but inclining slightly to the left in consequence of the position of the heart. Its area is not of equal extent throughout, being wider at the upper and the lower part of the sternum by reason of the divergence of the lungs from each other in these situations, and narrower about the middle; for here the lungs, when well distended with air, advance so nearly to the mesial line that their edges are all but in contact. The upper part of the space corresponds to the first bone of the sternum, and contains the origin of the sterno-hyoid and thyroid muscles, the remains of the thymus gland, and more or less cellular tissue and fat. The lower part inclines rather to the left side of the sternum in front of the pericardium. Here and there amongst the cellular tissue may perhaps be discovered absorbent glands variable in number and size; they receive the absorbents from the convex surface of the liver, the pericardium, and the heart.

99. Between the first bone of the sternum and the great vessels at the upper part of the chest, we have to clear away a certain quantity of fat and cellular tissue in order to expose a fascia which

very distinctly descends from the neck over the front of the trachea to the pericardium. After the removal of this fascia a little dissection will bring into view the great veins which return the blood from the head and upper limbs, viz. the right and left brachio-cephalic or innominate veins. On either side they are formed respectively by the junction of the subclavian and internal jugular near the sternal end of the clavicle; but since they differ in their course and relations we must describe each separately, and the left first, being the more conspicuous.

a. The *left brachio-cephalic vein* passes behind the first bone of the sternum from the left towards the right side, in order to join the vena cava superior. It is about three inches in length, and its direction inclines a little downwards, deviating more or less in different subjects from the horizontal line. In any case it necessarily crosses over the trachea and three primary branches of the arch of the aorta. We are reminded of this relation in some instances of aneurism of these great vessels: the vein becomes partially compressed between the aneurismal tumour and the sternum, and hence arise the great swelling and venous congestion of the parts from which it returns the blood. Another point of interest to observe is, that the upper border of the vein lies nearly on a level with the upper border of the sternum; in some instances it rises even higher, and we have seen it on several occasions crossing in front of the trachea a full inch above the sternum. The possibility of such an occurrence should be remembered in the performance of tracheotomy.

The veins terminating in the left brachio-cephalic are the middle thyroid, which descend in front of the trachea, the deep cervical, vertebral, and internal mammary; also small veins from the pericardium, mediastinum, thymus gland (in childhood), and occasionally the left superior intercostal vein. But all this is subject to variety.

b. The *right brachio-cephalic vein* descends nearly vertically to join the superior vena cava. It is about one and a half inch in length, and is situated about one inch from the mesial line of the sternum. Parallel with it on its left side runs the corresponding

arteria innominata; its right side is separated by the pleura from the upper lobe of the lung.

It commonly receives the vertebral, deep cervical, and occasionally the internal mammary veins.

100. *Vena cava superior.*—This is the great channel through which the blood, returning from the upper part of the body, is conveyed into the right auricle of the heart. The right and left brachio-cephalic trunks unite at nearly a right angle opposite the first intercostal space on the right border of the sternum; that is, about the level of the highest point of the arch of the aorta. Commencing from this junction, the vena cava descends nearly vertically with a slight inclination backwards, and after a course of from three to four inches opens into the upper part of the right auricle. In something less than the lower half of its course it is covered by the pericardium, and it will therefore be necessary to open this bag in order to observe that the serous layer of it is reflected over the front and the sides of the vein. In respect to its relations, we have to notice that the vein lies in front of the right bronchus and the right pulmonary vessels, and that it is partially overlapped on its left side by the great bulge of the ascending aorta. In the upper half of its course, namely that external to the pericardium, it is covered on its right side by the mediastinal layer of the pleura, and on this side, in close contact with it, descends the phrenic nerve.

Before it is covered by the pericardium the vena cava receives the vena azygos, and sometimes the right internal mammary vein.

101. Course and relations of the arch of the aorta.—The aorta is the great trunk from which all the arteries of the body carrying red blood are derived. It arises from the upper and back part of the left ventricle of the heart. Its origin is nearly opposite the upper border of the fourth costal cartilage of the left side, at its junction with the sternum. The vessel ascends forwards and to the right as high as the upper border of the second costal cartilage on the right side; it then curves backwards towards the left side of the body of the second dorsal vertebra, and turning

downwards over the third completes the arch. The direction of this arch is therefore from the sternum to the spine, and rather oblique from the right towards the left side. Simply for the convenience of description, it is usual to divide it into an ascending, a transverse, and a descending portion.

a. Ascending portion.—In order to see this portion of the aorta it is necessary to open the pericardium. We shall then observe that the artery is covered all round by the smooth and polished serous layer of the pericardium, excepting in the situation where it is in contact with the pulmonary artery. In respect to its relations we have to notice that its commencement is covered by the pulmonary artery, and more or less overlapped by the appendix of the right auricle. On its right side, but on a posterior plane, descends the superior vena cava; on its left is the division of the pulmonary artery; and immediately behind it is the right branch of this artery.

b. Transverse portion.—This portion of the aorta, proceeding backwards to the spine, crosses in front of the trachea a little above its bifurcation. It is separated from the sternum by the cellular tissue of the anterior mediastinum, by the remains of the thymus gland, and more or less in different cases by the left lung. Near its upper convex surface runs the left vena innominata; near its lower concave surface there is the left bronchus, and the bifurcation of the pulmonary artery, with the left branch of which it is connected by the remains of the ductus arteriosus.

The arch is crossed in this situation by the left phrenic and the left pneumo-gastric nerves; and the recurrent branch of the latter ascends behind it to the larynx.

c. Descending portion.—This part of the arch lies upon the left side of the body of the third dorsal vertebra. On its right side is the œsophagus and the thoracic duct; its left is covered by the mediastinal layer of the pleura.

Within the arch of the aorta are contained the following parts:—the left auricle, the left bronchus, the right pulmonary artery, the left recurrent nerve, the remains of the ductus arteriosus, and a number of absorbent glands.

d. Sinus aortæ.—The arch of the aorta presents partial dilata-

tions in certain situations, so that it deviates from the perfectly cylindrical form. One of these, called the sinus or great bulge of the aorta, is observable on the right side of the arch about the junction of the ascending with the transverse portion ; just in that situation where one might expect such a dilatation from the impulse of the blood. It is little if at all marked in the infant, but increases with age. Three other dilatations, one corresponding to each of the valves at the commencement of the aorta, will be examined hereafter.

e. Relations of the arch of the aorta to the sternum.—These necessarily vary in some measure, according to the size of the heart, the obliquity of the ribs, and the general development of the chest. In a well-formed adult the ascending aorta is, at the most prominent part of its bulge, about five-eighths of an inch distant from the first bone of the sternum. The highest part of the arch is on a plane about one and a half inch below the upper edge of the sternum. In infants it is relatively higher, in consequence of the incomplete development of the bone, and also in the aged, in consequence of the dilatation of the arch. But even in adults it may vary ; more especially if there be any hypertrophy of the heart. As an instance among many, we may mention that of a young female who died of phthisis. The position of the aortic valves was opposite the middle of the sternum on a level with the middle of the second costal articulation. The highest part of the arch was on a level with the upper border of the sternum ; the arteria innominata was situated entirely in front of the trachea ; and the left vena innominata crossed the trachea so much above the sternum that it would have been directly exposed to injury in tracheotomy.

From the upper part of the arch there commonly arise three great trunks for the supply of the head, neck, and upper limbs ; namely, the brachio-cephalic or innominate artery, the left carotid, and the left subclavian. These we shall examine in succession.

102. The *brachio-cephalic* artery arises from the commencement of the transverse part of the arch. It ascends with a slight inclination to the right, and after a course of about one inch and a half, divides behind the sterno-clavicular joint into two arteries of

nearly equal size—the right carotid, and the right subclavian. Concerning its relations we have to observe that it is situated more or less obliquely in front of the trachea. The right vena innominata descends on its right side; the left crosses in front of it. Parallel and close to the artery are the slender cardiac nerves.

In some cases this artery ascends for a short distance above the clavicle before it divides, lying close to the right of the trachea. We have already alluded to the fact that it occasionally gives off a middle thyroid artery which ascends in front of the trachea to the thyroid body, and is therefore directly exposed to injury in the operation of tracheotomy.

103. The *left carotid artery* arises from the upper part of the arch of the aorta close to the arteria innominata. It ascends rather obliquely outwards behind the first bone of the sternum to the neck. In the first part of its course it lies, more or less in different subjects, upon the trachea, but it soon passes to the left side of the trachea, and then lies for a short distance upon the œsophagus.

104. The *left subclavian artery* is the third branch of the transverse portion of the arch. It ascends almost perpendicularly out of the chest to the inner border of the first rib, and then curves outwards towards the scalenus anticus muscle. In the first part of its course it is very deeply seated, and is partially covered on its left side by the mediastinal layer of the pleura. Close to its inner side, and rather on a posterior plane, is situated the œsophagus; and between it and the œsophagus we find the thoracic duct. Like the other primary branches of the arch it is crossed by the left brachio-cephalic vein. The pneumo-gastric nerve descends parallel with it, but to its inner side; that is, between it and the left carotid. The upper part of its course, where the vessel gradually passes in front of the apex of the lung, has been described with the anatomy of the neck (§ 43, *b*).

105. The course of the *phrenic nerves* (already alluded to at § 42) may now be traced through the chest. On either side, the phrenic nerve enters the chest between the corresponding subclavian vein and artery. It then descends in front of the root of the lung between the mediastinal layer of the pleura and the pericardium to the diaphragm. Above the root of the lung the two

nerves have different relations; that is to say, the right proceeds successively along the outer side of the brachio-cephalic vein and the extra-pericardiac portion of the superior vena cava; whereas the left crosses in front of the transverse part of the aortic arch, a little to the right of the pneumo-gastric nerve. It should be noticed also that the left phrenic is the longer of the two, because it is rather diverted in its course by the oblique position of the heart.

In the upper part of the chest the phrenic is sometimes joined by a branch from the brachial plexus, and less frequently by a branch from the descendens noni (see § 16). In one instance we observed that this branch proceeded separately to the diaphragm.

On the upper surface of the diaphragm the phrenic divides into a number of diverging branches, which are distributed, some to the greater, others to the lesser crus of the muscle. A careful dissector may now and then trace a communication between some of its filaments and those proceeding from the semilunar ganglion, but we have never been able to discover those filaments which have been described as passing on to the liver.*

As to the question whether the phrenic ever supplies the pericardium, we have observed that in some rare instances one or more slender filaments may be traced to it from this nerve.

106. Having now finished the dry anatomical details of the great vessels at the upper part of the chest, it may be well to consider for a moment what kind of symptoms may be produced by an aneurism of the arch of the aorta, or any of the primary branches. A cursory glance at the important parts in the neighbourhood is sufficient to answer such a question. Of course the effects will vary according to the part of the artery which is the seat of the aneurism, and likewise according to the volume, the form, and the position of the tumor. One can easily understand that compression of the vena cava superior, or either of the brachio-cephalic veins, would occasion swelling and congestion of the parts from which it returns the blood; that compression of the trachea or one of the bronchi might occasion dyspnœa, and thus simulate

* Blandin, Nouv. Elem. d'Anatomie descript. Paris.

disease of the larynx*; and that compression of the œsophagus would give rise to the symptoms of stricture. Nor must we forget the immediate vicinity of the thoracic duct and the recurrent nerve,† and the effects which would be produced by their compression. One cannot, then, be surprised that a disease which may give rise to so many different symptoms should be a fertile source of fallacy in diagnosis.

It is well known that aneurisms of the aorta frequently prove suddenly fatal by bursting into the contiguous tubes or cavities; as, for instance, into the trachea, the œsophagus, the pleura, or the pericardium. Upon this subject it would be beside the purpose to dwell more than simply to direct attention to the anatomical reason why an aneurism of the first part of the arch of the aorta commonly bursts into the pericardium before it has attained any considerable size. It may be observed that in this part of its course the aorta is covered only by a thin layer of serous membrane: now if an aneurism takes place here, the several investing coats of the vessel soon become distended to their utmost, give way, and allow the blood to escape into the pericardium. This case is very different from what is observed during the progress of aneurisms in general; in which, in proportion as the sac enlarges, the surrounding parts, namely muscles, various other structures, and even bones, become involved in its composition, and in fact contribute to form part of the wall of the cavity.

107. Position and form of the heart.—The heart is situated obliquely in the chest, in the space between the lungs commonly called the mediastinum. It is supported by the tendinous centre of the diaphragm. It is maintained in its position by a membranous bag, termed the pericardium, which encloses it on all sides, yet so loosely that it does not confine its movements. If the pericardium be laid open it will be observed that the heart

* In the Museum of Guy's Hospital there is a preparation, No. 1487, in which laryngotomy was performed under the circumstances described in the text.

† See Med. Gaz. Dec. 22d, 1843. A case in which loss of voice was produced by the pressure of an aneurismal tumour upon the left recurrent nerve.

would be nearly conical in form, but for the flattening of its lower surface upon which it rests. Its base, that is, the part by which it is attached and from which its great vessels proceed, is directed upwards and to the right behind the sternum ; its apex downwards and to the left; and its long axis forms with the mesial line an angle of about 55°.*

Speaking, then, in general terms, we may say that the heart is placed behind the lower half of the sternum, that it occupies more of the left than the right half of the chest, and that it rests upon the left side of the central tendon of the diaphragm, which is nearly on a plane with the lowest part of the fifth rib. If a vertical line be drawn down the left margin of the sternum, about one-third of the heart will lie to the right of it, and the remainder to the left. At each contraction the apex of the heart may be felt beating between the fifth and sixth ribs at a point about two inches below the nipple, and one inch on its sternal side.

The flattening of the lower surface of the heart occasions two edges on its circumference, an upper and a lower, or a right and left. The upper edge (belonging to the left ventricle) is very thick and convex, and slants from the mesial line at an angle of about 35°; the lower edge (belonging to the right ventricle) is very much thinner, and nearly horizontal.

If we look at the upper surface of the heart we observe that it is convex, and that it is divided by a superficial longitudinal line proceeding from the base to the right side of the apex. A similar line is observable on the lower or flat surface. These lines are the principal trunks of the coronary arteries by which the walls of the heart are supplied with blood, and they indicate the septum or partition by which the ventricles are divided. At the base of the heart there are two other chambers, one on each side, each having a sort of pendulous portion (appendix) directed towards the mesial line: these are the auricles.

The outline of the heart traced upon the front wall of the chest

* The position of the heart in man affords evidence that he is expressly adapted to the erect position ; for in quadrupeds it is placed perpendicularly in the chest with the point downwards, and is unsupported by the diaphragm.

is called the præcordial region. It is important to be able to define this region with something like precision, though its extent may vary in a slight degree in different individuals. It is necessary to be aware how much of this region is covered and separated from the wall of the chest by intervening lung. "Take the fifth costal cartilage, and let a point midway between its junction with the sternum and its junction with the rib be the centre of a circle two inches in diameter."* This circle will, sufficiently for all practical purposes, define that part of the præcordial region which is naturally less resonant to percussion than the rest; for here the heart is uncovered except by pericardium and loose cellular tissue, and is very near the wall of the chest. In the rest of the præcordial region it is covered and separated from the chest by the intervening lung.

With regard to the position of the several valves at the base of the heart in reference to the wall of the chest, it may be observed that the mouth of an ordinary sized stethoscope will cover a portion of them all, if it be placed a little to the left of the mesial line of the sternum opposite the third intercostal space. They are all covered by a thin portion of lung; and for this reason we commonly ask a patient to suspend his breathing while we listen to his heart.

The position of the heart may be slightly altered by the position of the body. Of this any one may convince himself by leaning alternately forwards and backwards, by lying on this side and on that, placing at the same time the hand upon the præcordial region. He will thus find that he can in a slight degree alter the place and the extent of the impulse of the heart; and the reason of this is obvious. Inspiration and expiration also may alter the position of the heart, but not so much as is generally supposed, because the central tendon of the diaphragm is prevented from falling beyond a certain limit by its connexion with the pericardium.

108. *Pericardium.*—This is the membranous bag which encloses the heart and the commencement of the large vessels at its base.

* Latham on Diseases of the Heart.

Though it maintains the organ in its proper situation, yet is it sufficiently large to allow its perfect freedom of motion. In front it is overlapped, especially during inspiration, by the thin margin of the lungs, excepting at the lower part and to the left of the mesial line; that is, in the neighbourhood of the fifth costal cartilage. On either side it is covered by the mediastinal layer of the pleura; and behind it is the so-called posterior mediastinum. In structure it consists of an external fibrous and an internal serous layer, and is therefore called a fibro-serous membrane. The fibrous layer, constituting the chief strength of the sac, is intimately connected with the central tendon of the diaphragm, and superiorly is gradually lost upon the great blood-vessels of the heart. The internal or serous layer not only lines the fibrous, and that part of the tendon of the diaphragm which supports the heart, but is also reflected over the great vessels and the surface of the heart itself. Thus it forms a completely shut sac, of which the inner surface is smooth and polished, and constantly moistened by a small quantity of serous fluid to facilitate the movements of the heart.

By lifting the heart out of the pericardium, we at once see the manner in which the serous layer is reflected over the great vessels at its base. It covers the front part of the ascending aorta to the extent of two inches or more; also part of the superior vena cava and the pulmonary veins, especially on the left side. The inferior cava receives scarcely any covering from this membrane, since it opens into the right auricle almost immediately after passing through the tendon of the diaphragm.

109. *Position and form of the lungs.*—The lungs occupy the greater part of the chest, and are placed one on either side of the heart. Each is fastened in its appropriate cavity by the bronchial tube and the pulmonary vessels, forming what is appropriately called the root of the lung. Now the lung exactly fills the cavity in which it is placed, and their respective surfaces, always in mutual contact, are covered by a continuation of one and the same serous membrane, disposed like all others of the kind; that is, having lined the cavity it is reflected over the contained organ. The free surface of this membrane, called the pleura, is everywhere smooth and polished, and lubricated by a serous moisture. In an

animal recently killed and still warm, we see this moisture escaping in the form of a light smoke, but no actual fluid is observed in the chest. After the body has cooled, a certain quantity of serum oozes, by transudation, from the blood-vessels, and forms the "liquor pleuræ."

Like the cavity in which it is contained, each lung is rather conical in form. Its base, broad and concave, corresponds to the arch of the diaphragm, while its apex ascends, to the extent of an inch or more, into the root of the neck: the surface corresponding to the ribs is convex,—that corresponding to the mesial line is more or less concave, in adaptation to the form of the heart; and the left lung presents, at its lower and front border, an especial excavation for this organ. Each lung is commonly divided into an upper and a lower lobe by a long and deep fissure, which commences behind about three inches from the apex, and proceeds obliquely downwards to the front a little lower than the fifth costal cartilage. The upper lobe of the right lung is moreover divided by a second and smaller fissure, which passes from the larger one upwards and to the front, so as to slice off, as it were, a triangular portion, called the "middle lobe." But these fissures in the lungs are subject to considerable variety in their number and direction. We have seen as many as six in each lung. This multiplicity of the lobes reminds us of the normal condition of the lungs in the majority of animals.*

The dimensions of the right are greater than that of the left lung in all directions excepting the vertical; and the reason of this exception is at once obvious, viz. the greater elevation of the diaphragm on the right side, by the bulk of the liver. On an average, the right lung is to the left, in point of size, as 11 to 10.

Every practical surgeon should be able to define upon the walls of the chest the boundaries of the lungs, so that he may know what parts are naturally resonant on percussion. We will attempt to trace such a boundary line with something like precision, as far as the alternate expansion and contraction of the lung, during inspiration and expiration, will allow.

* The dog, horse, ox, and sheep, have seven lobes.

Commencing, then, from above, we find that the apex of the lung projects into the root of the neck for a short distance above the sternal end of the clavicle. This part of the lung deserves especial attention, because it is, more than any other, obnoxious to tubercular disease. From the end of the clavicles the lungs converge on either side towards the mesial line, where their thin edges almost meet opposite the junction of the second rib; therefore there is no lung behind the first bone of the sternum.

From the level of the second costal cartilage to the level of the fourth, the inner margins of each lung run parallel and almost close behind the middle of the sternum; consequently they overlap the great vessels at the root of the heart.

Below the level of the fourth costal cartilage the margins of the lungs diverge from each other, but not in an equal degree. That of the left curves pretty nearly in the course of the fourth costal cartilage, and at the lower part of its curve projects more or less over the apex of the heart. That of the right descends almost perpendicularly behind the sternum as low as the attachment of the ensiform cartilage, and then, turning outwards, corresponds with the direction of the seventh costal cartilage. It must be obvious that hypertrophy of the heart, or effusion into the pericardium, will not only raise above the ordinary level the point where the lungs diverge, but also increase their divergence: hence the greater dulness on percussion.

Posteriorly, the thin margin of the lung does not, under ordinary circumstances, descend lower than the tenth intercostal space.

110. *Pleura.*—This is the serous membrane which we have already in great measure described in connexion with the lung. It now remains only to say that it forms a completely closed sac, one on either side of the chest; and that its several parts have received different names, according to the surface to which they are attached: such, for instance, as the pleura costalis, pleura pulmonalis, diaphragmatica, mediastinalis, &c. From the lower part of the root of each lung a triangular fold of the pleura, more or less apparent in different subjects, extends to the diaphragm. This is called the "*ligamentum latum pulmonis.*" In corpulent individuals we often find considerable deposits of fat near the medias-

tinum and the diaphragm, projecting in the form of pendulous processes, like the "appendices epiploicæ" of the intestines, and covered by the pleura. But no fat is ever found upon the surface of the lung.

It is necessary to be aware that the line of reflection of the pleura from the diaphragm to the ribs is not, in all cases, exactly the same at the back of the chest. Generally speaking, it takes place about the level of the lower border of the last rib. But it may take place at the eleventh, tenth, or even the ninth rib, and in one instance we have seen it as high as the eighth. Under such circumstances the space in which the lungs could expand posteriorly, would be proportionately diminished. In these exceptional cases the conformation of the parts was natural, and not the result of disease.

111. Posterior mediastinum and its contents.—We must first raise the right lung out of the chest, and fasten it towards the left side. The so-called posterior mediastinum is a space left in front of the spine between the two mediastinal layers of pleura for the passage of the aorta, œsophagus, thoracic duct, &c. through the chest. To expose these parts we have merely to remove the pleura, and a tolerably compact layer of fibrous tissue. With a very little dissection, the contents of the posterior mediastinum will be exposed in the following relative position:—

The descending aorta lies close to the spine. In front of the aorta is the œsophagus surrounded by the œsophageal plexus of nerves, and here and there an absorbent gland. Along the right side of the aorta, close to the spine, runs the vena azygos. Between the aorta and the vena azygos is the thoracic duct. Each of these should be separately examined, and first the aorta.

112. *Thoracic aorta.*—We have already traced the arch of the aorta to the left side of the body of the third dorsal vertebra (see § 101). From this point the great artery descends on the left side of the spine, gradually approaching towards the mesial line. Nearly opposite the last dorsal vertebra it passes between the crura of the diaphragm and enters the abdomen. Its left side is covered by pleura: on its right side run the vena azygos and thoracic duct;

in front of it, and nearer to the mesial line, is the œsophagus. Its branches will be presently described.

113. *Vena azygos.*—This vein commences in the abdomen by small branches from one or more of the lumbar veins, and generally communicates with other veins in this region—namely, the renal, supra-renal, phrenic, or even the vena cava itself. It enters the chest through the aortic opening of the diaphragm, and ascends on the right side of the aorta through the posterior mediastinum; nearly on a level with the third dorsal vertebra, it arches forwards over the right bronchus, and terminates in the superior vena cava. In its course it receives the eight or nine lower intercostal, the œsophageal, and commonly the right bronchial veins. It may be observed that these several veins correspond to the branches of the descending thoracic aorta; and we may regard the azygos trunk itself as a kind of supplement to the vena cava, placed in the chest for the purpose of receiving them.

a. But another vein, called "vena azygos minor," in contradistinction to the preceding which is called the "major," runs for the same purpose along the left side of the spine; so that the term "azygos" would seem to be misapplied. This vein commences in the abdomen by small branches, and ascends with the aorta along the left side of the spine. On a level with the sixth or seventh dorsal vertebra, it passes beneath the aorta and joins the azygos major. It receives the five or six lower intercostal veins of the left side. None of these veins are provided with valves.

114. *Thoracic duct.*—This duct will be found close to the spine, in the cellular tissue between the aorta and the vena azygos. Although it is generally about the size of a crow-quill, it may be easily overlooked on account of the delicacy and transparency of its coats. It is the main channel through which the chyle from the intestines, and the contents of the absorbents from the greater part of the body, are conveyed into the blood. If we trace it into the abdomen, we find that it is formed by the confluence of the absorbent vessels from the intestines and the lower limbs. One of these tributary trunks, and occasionally the duct itself, presents a dilatation more or less marked in different instances, called the "receptaculum chyli." From this receptacle it is advisable to

inject the duct with melted wax or tallow, so that it may be the more readily followed in its course through the chest.

From the abdomen, the thoracic duct passes through the aortic opening of the diaphragm, and ascends on the right side of the aorta, receiving in its course the lymphatic vessels of the adjacent parts. About the third or fourth dorsal vertebra it passes under the œsophagus, and ascends on the left side of this tube, between it and the subclavian artery, as high as the level of the seventh cervical vertebra. Here it describes a curve with the convexity upwards, and opens into the back part of the confluence of the jugular and subclavian veins. The orifice is guarded by two valves, which permit the passage of fluid from the duct into the vein, but not vice versâ: other valves, disposed like those of the venous system, are found at intervals in different parts of the duct.

The thoracic duct may vary in size in different individuals. We have seen it of all sizes, intermediate between a crow-quill and a goose-quill. It may divide in its course into two branches, which subsequently re-unite; or instead of one, there may be several terminal orifices. Instances have been observed in which the duct has terminated on the right instead of the left side.* It has been seen to terminate in the vena azygos.†

115. *Œsophagus.*—This name is given to that part of the alimentary canal which conveys the food from the pharynx to the stomach. It commences about the fifth cervical vertebra, and, descending through the back part of the chest, passes through a special opening in the diaphragm to the stomach. It is from nine to ten inches in length. The direction of its course is not exactly vertical: in the neck, we have seen that it lies behind and rather to the left of the trachea; in the chest, however, about the fifth dorsal vertebra, it inclines towards the right side, to make way for the aorta, but it again inclines to the left before it perforates the diaphragm. It is surrounded on all sides by an abundance of loose cellular tissue, so that no obstacle is presented to the passage of the food.

* Fleischman, Leichenœffnungen. 1815.
† Müller's Archives. 1834.

The œsophagus is composed of two coats, a muscular and a mucous; and these are very loosely connected together by firm cellular tissue, which some anatomists describe as a distinct membrane. The muscular coat consists of an outer longitudinal, and an inner circular layer of fibres. The longitudinal layer is particularly strong, and arranged all round the œsophagus so as to support the circular. The mucous membrane is of a pale colour, and considerable thickness, and in the contracted state of the œsophagus is arranged in longitudinal folds. It is protected by a thick layer of scaly epithelium. In the submucous tissue are found a number of small glands, especially towards the lower end of the œsophagus.

116. COURSE AND BRANCHES OF THE PNEUMOGASTRIC NERVES.—We must in the next place trace the course and branches of the pneumogastric nerves through the chest. The right pneumogastric nerve, entering the chest between the subclavian artery and vein, descends by the side of the trachea, and then behind the right bronchus to the posterior surface of the œsophagus, upon which it divides into many branches, which form a plexus (posterior œsophageal) upon the tube. The left pneumogastric nerve descends into the chest between the left subclavian and the left carotid arteries, crosses in front of the arch of the aorta, and then passes behind the root of the lung to the anterior surface of the œsophagus, upon which it also forms a plexus (anterior œsophageal). The branches of the pneumogastric nerve in the chest are as follows:—

a. The *inferior laryngeal* or *recurrent.*—This nerve on the right side turns under the subclavian artery, on the left under the arch of the aorta, and ascends to the larynx.

b. Cardiac branches.—These are very small, and join the cardiac plexus.

c. Pulmonary branches.—These accompany the bronchial tubes. The greater number are seen behind the root of the lung, forming the posterior pulmonary plexus. A few only, forming the anterior pulmonary plexus, proceed over the front of the lung's root. Both these plexuses are joined by filaments from the sympathetic system.

But the nerves of the lungs are very small, and cannot be traced far into their substance.*

d. Œsophageal plexus.—We have already mentioned that below the root of the lung each pneumogastric nerve is subdivided so as to form a coarse interlacement of nerves round the œsophagus (plexus gulæ). From this plexus numerous filaments supply the coats of the tube; but the majority of them are collected into one, two, or more nerves, which pass with the œsophagus through the diaphragm for the supply of the stomach.

Having examined the contents of the posterior mediastinum from the right side, we should now do so from the left, in order to complete our knowledge of it. Turn, therefore, the left lung out of its cavity and fasten it towards the right side. After removing the pleura, a full view is presented of the descending thoracic aorta, of the pneumogastric nerve crossing the arch and sending the recurrent branch through it, also of the first part of the course of the left subclavian, covered externally by pleura. Trace the pneumogastric nerve to the œsophagus, and dissect the œsophageal plexus on this side. Lastly, notice the lesser vena azygos, described at § 113, *a*.

117. *Thoracic portion of the sympathetic.*—This may be traced on the one side or the other, but it is best to do so on the right. The sympathetic nerve extends nearly longitudinally along either side of the spine over the heads of the ribs. In its substance are observed a series of ganglia, one generally upon the head of each rib; but they may vary in number and size, for it often happens that two ganglia, generally the upper, coalesce, and under such circumstances the one ganglion so formed will of course be larger than the rest.

Each ganglion commonly receives two branches from the corresponding spinal nerve. The nerves proceeding from the ganglia supply the thoracic and part of the abdominal viscera. They are as follows:—

a. Minute nerves from the first and second ganglia to the *cardiac plexus*.

* Upon this subject, see the beautiful plates of Scarpa.

b. Minute nerves from the third and fourth ganglia to the *pulmonary plexus.*

c. The *greater splanchnic* nerve.—This is generally formed by branches from the sixth to the tenth ganglion. The branches descend obliquely along the sides of the bodies of the vertebræ, and unite into a single nerve, which passes through the corresponding crus of the diaphragm and joins the great semilunar ganglion of the abdomen.

d. The *lesser splanchnic* nerve.—This is commonly formed by branches from the tenth and eleventh ganglia. It passes through the crus of the diaphragm to the renal plexus, giving, in its course, a filament to the semilunar ganglion.

e. In a very few instances we have been able to trace a minute filament from one of the ganglia into the body of a vertebra. According to a celebrated French anatomist,* each vertebra receives one.

118. *Intercostal muscles.*—These, as their name implies, fill up the intervals between the ribs. Between each rib there are two layers, which cross each other like the letter X. The external layer is attached to the opposite borders of two contiguous ribs, and the direction of its fibres is obliquely from behind forwards, just like those of the external oblique muscle of the abdomen. The internal layer is attached to the inner border of two ribs, and its fibres run directly opposite to the preceding, like those of the internal oblique. It may be observed that a few fibres, chiefly near the spine, pass over one or even two ribs, and terminate upon a rib lower down.

But neither of these layers extends throughout the whole distance between the sternum and the spine : for the outer layer, beginning at the spine, ceases at the cartilages of the ribs; while the inner, commencing at the sternum, ceases at the angles of the ribs.

The intercostal muscles present a curious intermixture of tendinous and fleshy fibres; and they are covered both inside and outside the chest by a glistening fascia, for the purpose of giving greater strength and protection to the intercostal spaces.

* Cruveilhier.

Action.—They raise the ribs. But the ribs, in consequence of their obliquity, cannot rise without moving outwards, and thus increasing the capacity of the chest in the lateral direction. In rising, too, they necessarily increase the distance between the sternum and the spine, and thus enlarge the capacity of the chest in the antero-posterior direction. Of course it is understood that the upper ribs are fixed by the action of the scalene muscles, in order that each succeeding rib may become a fixed point for the rib below. We cannot but admire the simplicity of the contrivance by which this double expansion of the chest is produced—namely, the oblique direction of the ribs; for if they had been articulated at right angles with the spine, the capacity of the chest must have been diminished whether they rose or fell.

119. *Intercostal arteries.*—To see these, the inner layer of muscles should be removed from a few of the intercostal spaces. Each space has its own artery. The two upper are supplied by the intercostal branch of the subclavian (see § 48); the rest are supplied by the aorta: and since this vessel lies rather on the left side of the spine, the right intercostal arteries will be longer than the left. The upper intercostal arteries from the aorta necessarily ascend more or less obliquely to reach their intercostal spaces; the lower run more transversely. At the commencement of the space each divides into an *anterior* and a *posterior* branch.

a. The *anterior,* both in point of direction and size, appears the continuation of the common trunk. At first it runs along the middle of the intercostal space, and is separated from the cavity of the chest only by the pleura and intercostal fascia. In this situation, therefore, it is liable to be injured by a punctured wound in the back. But near the angle of the rib it passes between the layers of intercostal muscles, and occupies the groove prepared for its protection in the lower border of the rib. Here, too, it is necessary to observe that it gives off a tolerably constant branch, which runs for some distance along the upper border of the rib below and is lost in the muscles. In some cases we have seen this branch as large as the intercostal itself, and so situated as to be directly exposed to injury in the operation of tapping the chest.

In its course along the intercostal space, each artery sends a

multitude of small branches, which supply the intercostal muscles and form a delicate plexus of vessels both on the outer and inner surface of the rib. About midway between the sternum and the spine each gives off an external branch of variable size, which accompanies the lateral cutaneous branch of the intercostal nerve. The continued trunk, gradually decreasing in size, becomes very small towards the anterior part of its space, and is placed more in the middle of it. Those of the true intercostal spaces finally inosculate with branches of the internal mammary (see § 96 *c*). Those of the false are lost between the layers of the abdominal muscles.

b. The *posterior* branch passes backwards between the transverse processes of the vertebræ, and supplies the muscles and integuments of the back. Each of these sends an artery through the corresponding intervertebral foramen to the spinal cord and its membranes.

The intercostal vein returns the blood from the parts supplied by the artery, and terminates in the vena azygos.

120. *Intercostal nerves.*—These are, severally, anterior divisions of the spinal nerves. They proceed, one along each intercostal space, in company with and immediately below the corresponding vessels. In their course they supply the intercostal muscles; also lateral cutaneous branches (see Arm, § 12) and anterior cutaneous branches (see Arm, § 3). Observe that the first dorsal nerve, after furnishing a nerve to the first intercostal space, ascends over the neck of the first rib, and contributes to form the brachial plexus.

Intercostal absorbent glands.—These are situated chiefly near the heads of the ribs; but there are some between the layers of the intercostal muscles. They are of small size, and send their absorbent vessels into the thoracic duct.

121. *Bronchial* and *œsophageal arteries.*—Small arteries, arising from the concavity of the arch of the aorta, accompany the bronchial tubes into the substance of the lung. Their distribution and office will be considered with the anatomy of that organ. Other arteries, still smaller, proceed from the front of the descending aorta and supply the œsophagus.

Having finished the examination of the contents of the posterior mediastinum, we should replace the lung and turn our attention once more to the great vessels at the root of the heart. We have also to examine the cardiac plexus. Let us begin with the pulmonary artery.

122. *Pulmonary artery.*—This vessel carries the impure blood from the heart to the lungs. It proceeds from the right ventricle, crosses obliquely in front of the root of the aorta, and on the left side of that vessel divides into two branches, one for each lung. The right branch passes through the arch of the aorta to the right lung; the left is easily followed to its corresponding lung by dissecting off its investing layer of pericardium.

Draw towards the left side the first part of the arch of the aorta, and dissect the serous layer of the pericardium from the great vessels at the base of the heart. By this proceeding a good view will be obtained of the trachea and its bifurcation into the two bronchi. Below the division of the trachea the right pulmonary artery is seen passing in front of the right bronchus. The superior vena cava is seen descending in front of, and nearly at right angles to, the right pulmonary artery. The vena azygos is also seen arching over the right bronchus and terminating in the vena cava. It will be necessary to remove a number of absorbent glands called the bronchial, of which the larger are found at the angle of bifurcation of the trachea. The situation of these glands in the midst of so many tubes explains the variety of symptoms which may be produced by their enlargement.

123. *Cardiac plexus of nerves.*—The nerves of the heart are derived from the pneumogastric and from the cervical ganglia of the sympathetic. A very general description of them will suffice, because they are subject to very great variety. It is essential to know that most of these nerves converge towards the posterior part of the arch of the aorta. Here they form an intricate plexus called the "*great cardiac,*" and in it we may recognise two or more ganglia. The precise situation of this plexus is between the trachea and the arch of the aorta, and above the bifurcation of the pulmonary artery. One or more cardiac nerves, usually from the left side, pass in front

of the arch of the aorta, and form what is called the "*superficial cardiac plexus*:" but this is very small compared to the other.

From this plexus the greater number of nerves proceed, in company with the coronary arteries, to the heart; but some are distributed to the pericardium and the lungs.

Those nerves which accompany the anterior coronary artery form what is called the "anterior coronary plexus." It is best seen by dissecting between the aorta and the pulmonary artery. The posterior coronary plexus proceeds with its corresponding artery to the posterior part of the base of the heart.

But it is not an easy matter to trace the nerves into the substance of the heart. For this purpose a horse's heart is the best, and some previous maceration in water is desirable.

124. Draw aside the margin of the right lung; divide the superior vena cava above the vena azygos, and turn down the lower part. Remove the layer of pericardium which covers the pulmonary veins, and the constituent parts of the root of the right lung will be exposed. They lie from before backwards in the following order:—In front are the two pulmonary veins; behind the veins are the subdivisions of the pulmonary artery; and behind the artery are the divisions of the bronchus. From above downwards they are disposed thus:—The bronchus is the highest; then comes the pulmonary artery; while the vein is the lowest. The parts are arranged just the same in the root of the left lung, except that the artery is placed higher than the bronchus.

DISSECTION OF THE HEART.

For this purpose, the heart, together with the lungs, should be removed from the chest. The reader is presumed to be familiar with the general form of the heart, described at § 107. He should notice the longitudinal groove both on the upper and lower surface, indicating the divisions of the ventricles; and the circular groove near the base, indicating the separation between the ventricles and auricles. These grooves are occupied by the coronary vessels, and

by more or less fat, according to the general condition of the body.

125. The human heart is a double organ; that is to say, it is composed of two hearts, a right and a left, separated by a septum. Each consists of an auricle and a ventricle, which communicate by a wide orifice: the right propels the blood through the lungs, and is therefore called the *pulmonic;* the left propels the blood through the body generally, and is therefore called the *systemic.* These two hearts, it is true, are not placed apart, because important advantages result from their union. By being enclosed in a single membranous bag they occupy less room in the chest; and the action of their corresponding cavities being precisely synchronous, their fibres, mutually intermixing, contribute to their mutual support. We shall describe the several cavities of the heart in the order in which the blood circulates through them.

126. *Right auricle.*—This is situated at the right side of the base of the heart, and it forms a quadrangular cavity between the two venæ cavæ, from which it directly receives the blood. From its front a small pouch or cul-de-sac projects towards the left, more or less overlapping the root of the aorta: this appendage to the general cavity is the "*auricula,*" so called from its fancied resemblance to the ear of a dog.

To see the interior of the auricle, make a horizontal incision through the anterior wall, and from this make another at right angles into the superior cava. We observe that its interior is lined by a thin polished membrane, and that it is everywhere flat, except in the appendix, where the muscular fibres are collected into bundles, called, from their fancied resemblance to the teeth of a comb, "*musculi pectinati.*" They appear to radiate from the auricles to the edges of the auriculo-ventricular opening. In the intervals between them the wall of the auricle is so thin that it is composed only of the outer and inner membranes of the heart. Observe the openings of the two venæ cavæ: they are not directly opposite to each other, the superior being situated on a plane rather in front of the inferior, in order that the two streams of blood may not meet. The orifice of each is nearly circular, and surrounded

by a few muscular fibres continuous with those of the auricle. On the posterior wall of the auricle between the orifices of the veins, some anatomists speak of a prominence to which the name "tuberculum Loweri"* has been given. We have never seen anything of the kind in the human heart, though it may be observed in that of many quadrupeds.

The left wall of the auricle is formed by the septum auricularum. Upon this septum, immediately above the orifice of the vena cava inferior, there is an oval depression *(fossa ovalis)*, bounded by a prominent border *(annulus ovalis)*. This depression marks the position of the opening *(foramen ovale)* through which the auricles communicated in fœtal life. After birth this opening closes; but if it should so happen that the closure is imperfect, the stream of dark blood in the right auricle mixes with the florid blood in the left, and occasions the symptoms of the disease called "morbus cœruleus."

Extending from the anterior margin of the opening of the vena cava inferior to the anterior border of the fossa ovalis, is seen in some subjects a thin fold of the lining membrane of the heart: it is the remains of what was, in fœtal life, the Eustachian† valve. The direction of this valve in the fœtus is such that it tends to direct the current of blood from the inferior cava towards the foramen ovale. It is at that period of life a valve of considerable size, and contains a few muscular fibres; but after birth it gradually disappears, being no longer required. To the left of this—that is, between the vena cava inferior and the auriculo-ventricular opening—there is the orifice of the coronary vein; it is more or less covered by a semicircular valve, called "*valvula Thebesii.*" Here and there upon the posterior wall of the auricle may be observed minute openings called "*foramina Thebesii*:" they are the orifices of small veins returning blood from the substance of the heart. Lastly, to the left and rather in front of the orifice of the vena cava inferior is the auriculo-ventricular opening. It is oval in form, and will usually admit the passage of three fingers.

* Richard. Lower, Tractatus de Corde, &c. London, 1669.

† Eustachius, Libell. de vena sine pari.

There are 5 openings into the right auricle

1 Auriculo-ventricular

127. *Right ventricle.*—This forms the right border and about two-thirds of the upper surface of the heart. To examine its interior, a triangular or V-shaped portion should be raised from its anterior wall. We observe that its wall is much thicker than that of the auricle, and that its thickness gradually diminishes towards the apex of the heart. The cavity of the ventricle is rather conical in form, with its base upwards and to the right. Its walls present a multitude of prominent bands of muscular fibres *(columnæ carneæ)* of various length and thickness, which cross each other in every direction, so as to occasion a reticulated appearance ; and this network is generally found filled with coagulated blood. Of these columnæ carneæ we notice three kinds :—one kind stands out only in high relief as it were from the ventricle ; another is attached to the ventricle by their extremities only ; a third, and by far the more important set, called "*musculi papillares*" is fixed by one extremity to the ventricle, while the other projects towards the auricle, and terminates either in a blunt extremity or in several short processes. To the summits of this last set are attached fine tendinous cords *(cordæ tendineæ)*, which pass from thence to the auriculo-ventricular or tricuspid valve. The number of these musculi papillares is always equal to the number of the chief divisions of the valve ; consequently there will be three in the right, and two in the left ventricle. Of those in the right ventricle, one proceeds from the septum.

There are two openings in the right ventricle. One, called the auriculo-ventricular, through which the blood passes from the auricle, is placed at the base of the ventricle. It is surrounded by a ring of fibrous tissue, to which is attached the tricuspid valve, which will be presently described. From the upper and front part of the ventricle, a smooth short passage, sometimes called the "*infundibulum,*" leads to the other opening—that, namely, of the pulmonary artery. It is situated to the left and in front of the auriculo-ventricular, and about three-fourths of an inch higher. Between the two openings the muscular substance of the ventricle projects like a prominent ridge.

128. *Tricuspid valve.*—This is situated at the right auriculo-ventricular opening. Like all the valves of the heart, it is formed

Ventricle
Right ~~Auricle~~ has 2 openings.
1 Auriculo-Ventricular.
2 Pulmonary Artery.

by a fold of the lining membrane of the heart, strengthened by a certain amount of fibrous tissue. The base of the valve is attached to the tendinous ring round the opening. Its free or floating border is very irregular, and presents three principal triangular flaps; and besides these, intermediate ones of smaller size. Of the principal flaps, the largest is so placed that when not in action it partially covers the orifice of the pulmonary artery.

It is interesting to observe the arrangement of the tendinous cords through which the proper action of the valve is regulated. In the first place they are all attached to the outer or ventricular surface of the valve. Secondly, all the tendinous cords proceeding from one papillary muscle are attached to the adjacent halves of two of the larger flaps, and to a smaller intermediate one; consequently, when the ventricle contracts, and with it the papillary muscle, the adjacent borders of the flaps will be approximated. Thirdly, in order to ensure the strength of every part of the valve, the tendinous cords are inserted at three different points of it in straight lines; accordingly, they are divisible into three sets. Those of the first are attached to the base of the valve and the auriculo-ventricular ring; those of the second are attached at intervals to the back of the valve; those of the third are attached to its loose border.

The best mode of showing the action of the valve is to introduce a glass tube into the pulmonary artery, and then to pour water through it into the ventricle until the cavity is quite distended. By gently squeezing the ventricle in the hand, so as artificially to imitate its natural contraction, the tricuspid valve will flap back like a flood-gate, and so close the auriculo-ventricular opening. In this way one can readily understand, how, when the ventricle contracts, the blood catches the margin of the valve, and by its very pressure gives it the proper distension and figure requisite to block up the aperture into the auricle. It is also obvious that the tendinous cords will prevent the valve from being pushed too far back into the auricle; and this purpose is assisted by the papillary muscles, which nicely adjust the degree of tension of the cords at a time when they would otherwise be too much slackened by the contraction of the ventricle.

129. *Pulmonary* or *semilunar valves.*—These consist of three membranous folds situated at the orifice of the pulmonary artery. Their convex borders are attached to the fibrous ring at the root of the artery; their free or floating edges present a doubly festooned border, in the centre of which there is a little cartilaginous body called the "nodulus," or "*corpus Arantii.*" The use of these little bodies is very obvious. Since the valves are semilunar, when they fall together they could not exactly close the artery; there would be a space of a triangular form left between them in the centre, just as there is when we put the thumb, fore, and middle fingers together. This space is filled by the little bits of cartilage, so that the septum becomes complete.

As already mentioned, the valves are composed of a duplicature of the delicate endocardium, or lining membrane of the heart. But since this would not of itself be sufficiently strong, we find between the folds a thin layer of fibrous tissue, which is prolonged from the tendinous ring at the orifice of the artery. It is to be observed, however, that this layer of fibrous tissue reaches the free edge of the valve at three points only; namely at the centre, or corpus Arantii, and at each extremity. Between these points it stops short, and leaves a crescent-shaped portion of the valve thinner than the rest, and consisting simply of endocardium. This crescent-shaped portion is called by some anatomists the "*lunula;*" but it is not wholly without fibrous tissue, for we notice that a thin tendinous cord runs along its free edge for the purpose of giving it additional strength to resist the impulse of the blood; just in the same manner that sails are strengthened by cords along their edges, that they may not be torn by the action of the wind. Behind each of the valves the artery bulges somewhat outwards, so as to form three slight dilatations called the "*sinuses of Valsalva.*" These, we shall presently see, are more marked at the orifice of the aorta.

The action of these valves is exceedingly obvious. During the contraction of the ventricle the valves lie against the side of the artery, and offer no impediment to the current of blood; during its dilatation, the elasticity of the distended artery would tend to force back the column of blood, but that the valves, being caught by the

refluent blood, bag, as it were, and fall together so as to close the calibre of the tube. The greater the pressure, the more accurate is the closure. In the production of this result it should be remembered that the coats of the artery are very elastic and yielding, while the whole structure of the valve, as well as the circumference to which it is attached, is quite unyielding; consequently, when the artery is distended by the impulse of the blood, its wall is removed from the contact of the free margin of the valves, and these are the more readily caught by the least retrograde motion of the blood. The force of the reflux is sustained by the tendinous part of the valves; and, according to Haller, they are capable of sustaining a weight of 63lbs. before they give way. But the thinner portions, or the lunulæ, become placed so as to lie side by side, each one with that of the adjacent valve. All this may be at once seen by filling the artery with water.

130. *Left auricle.*—This is situated at the left side and posterior part of the base of the heart. In shape it is somewhat quadrilateral, and it receives the pulmonary veins, two on either side, which return the purified blood from the lungs. From its upper and left side the auricular appendage projects towards the right, advancing over the root of the pulmonary artery. The cavity of the auricle should be opened by a horizontal incision proceeding from one pulmonary vein to another: from this a second should be made into the appendix. Its interior is smooth and flat, excepting in the appendix, where the "*musculi pectinati*" are observed. We should notice the openings of the four pulmonary veins. Upon the septum between the auricles is seen a depression indicating the remains of the foramen ovale; and this is limited below by a crescent-shaped edge, which is part of the remains of that valvular apparatus. At the lower and front part of the auricle is the auriculo-ventricular opening. It is of an oval form, with its long axis nearly transverse, and in the adult commonly admits the passage of about two fingers.

131. *Left ventricle.*—This occupies the left border, and forms the apex of the heart. One-third of it only is seen on the upper surface. To examine the interior, raise a triangular portion from its front wall. It will then be observed that it is about three times

Left auricle has 5 openings
Auriculo-ventricular 1
4 Pulmonary veins.

as thick as that of the right, and that this thickness gradually diminishes towards the apex. The interior of the left ventricle is so much like that of the right that it would be superfluous to describe it in detail. We need merely observe that the auriculo-ventricular valve consists of only two principal flaps: hence its name "*mitral*" or "*bicuspid.*" The larger of these flaps is placed between the aortic and auricular orifices. There are only two "*musculi papillares;*" one attached to the anterior, the other to the posterior surface of the ventricle. They are naturally thicker, and their "*cordæ tendineæ*" stronger than those of the ~~heart~~ right, but the plan upon which they are arranged is precisely similar. From the upper and back part of the ventricle a smooth passage leads to the orifice of the aorta. It is placed rather in front and to the right side of the auriculo-ventricular opening; but the two are close together, and only separated by the larger flap of the mitral valve. Its orifice is guarded by three semilunar valves, of which the arrangement, structure, and mode of action, are precisely like those of the pulmonary artery. Of course their framework is proportionately stronger, consistently with the greater strength of the left ventricle and the greater impulse of the blood. In the "*sinuses of Valsalva*" are observed the orifices of the coronary arteries.

At the openings between the auricles and the ventricles, and also at the commencement of the aorta and pulmonary artery, we find rings or zones of fibrous tissue, which serve as fixed points for the attachment of the muscular fibres of the heart.

132. *Mode in which the great arteries are attached to the ventricles.*—The upper edge of the fibrous ring at the arterial orifice of the ventricle is excavated into three concavities, into which the middle or elastic coat of the artery accurately fits, and is very firmly attached. To the line of union are fixed the semilunar valves. The vessels are also connected to the heart by the serous layer of the pericardium, and by a continuation of the lining membrane of the ventricle (endocardium).

133. *Arrangement of the muscular fibres of the heart.*—Most of the fibres are attached by both extremities to the fibrous rings of the heart, either directly or through the medium of the cordæ tendineæ.

The fibres of the auricles are quite distinct from those of the

Left ventricle has 2 openings
1 Auriculo-ventricular
2 Aortic.

ventricles. They consist of a superficial layer common to both cavities, and a deeper layer proper to each. The superficial fibres run for the most part transversely across the auricles, and a few pass into the septum. The deeper fibres run in circles chiefly round the auricular appendages and the entrance of the great veins, upon which a few may be traced for a short distance.

Of the ventricular fibres, some are common to both ventricles, others proper to each. The septum is formed principally by the fibres of the left. All the fibres take a more or less spiral course from the base towards the apex of the heart, where they coil round, pass into the interior of the ventricle, and form either "carneæ columnæ" or "musculi papillares."*

134. *Weight.*—The average weight of the heart is from ten to twelves ounces in the male, and from eight to ten in the female: but much depends upon the size and condition of the body generally. We have seen the heart so reduced in size by diabetic disease that it weighed only $5\frac{1}{2}$ oz. As a general rule, it may be stated that the heart gradually increases in length, breadth, and thickness, from childhood to age.†

135. *Relative thickness of the cavities.*—Of course the measure must not be taken during the "rigor mortis." The average thickness of the right auricle is about one line; that of the left, one and a half.

The average thickness of the wall of the right ventricle at its thickest part—*i. e.*, the base—is about two lines. The average thickness of the left ventricle at its thickest part—*i. e.* the middle—is about $5\frac{1}{6}$ of a line. In the female the average is less.

STRUCTURE OF THE LUNGS.

136. The lungs are very vascular, spongy organs, through which the blood passes in its course from the right to the left side of the heart, and in which it is purified by means of exposure to

* For further information upon this subject, see the article in Todd's Cyclopædia.

† Consult Bizot, Mém. de la Soc. Méd. d'Obser. de Paris, tom. i. 1836.

the atmospheric air. Their situation and shape have been already described (§ 109). Our chief concern now is with their general structure, and the anatomy of their component parts.

The lungs are composed of cartilaginous and membranous tubes, of which the successive subdivisions extend through its substance and convey the air into a congeries of closely-packed and minute cells, commonly called the air vesicles; of the ramifications of the pulmonary artery and veins; of the bronchial vessels concerned in their nutrition; of lymphatics and nerves. These component parts are all united by a fine cellular tissue, and covered externally by the reflected pleura. The point at which they respectively enter and pass out is called the root of the lung.

The air-cells of which the lung consists are dilated in inspiration, and still penetrated with air even in the most complete expiration. The most numerous incisions and the strongest pressure will hardly get rid of all the air from the lungs. In consequence of this they are the lightest organs in the body, and swim when immersed in water. But when entirely deprived of this air, and reduced as it were to their own substance, they sink. This is observed in certain pathological conditions; as, for instance, when one lung is compressed by effusion into the chest, or when it is rendered solid and impervious to air by inflammation.

137. *Contractility of the lung.*—If a wound be made into the chest in the dead subject, the lung, which was before in contact with the pleura, immediately recedes from it, and, provided there be no adhesions, gradually diminishes in volume. Again, if the lungs be artificially inflated, either in or out of the chest, we observe that, if left to themselves, they spontaneously expel a part of the air. This constant disposition to contract, inherent in the living and the dead lung, is owing to a certain amount of elastic tissue in the bronchial tubes and the air-cells; but more especially to a layer of very delicate elastic tissue which is spread over the surface of the lung, and which has been described by some anatomists as a distinct coat, under the name of the second or inner layer of the pleura.*

* In some animals, the seal especially, the elasticity of this tissue is very strongly marked.

138. *Colour.*—In consequence of the accumulation of blood which takes place in their vessels, the lungs are commonly of a livid red or violet colour; and they often present a mixture of tints, giving them a marble-like appearance. We must not consider this as the natural colour of the organ, since it is merely produced in the act of dying. It depends upon the stagnation of the venous blood, which the right ventricle still impels into the lungs, though respiration is failing. The tint varies in particular situations in proportion to the accumulation of the blood, and is of course always the deepest at the most depending part of the lung—that is, at the back, in accordance with the laws of gravity. But the colour of the proper tissue of the lung apart from the blood which it contains is pale and light grey. This pale colour is seldom seen except in the lungs of infants who have never breathed, or in cases of death from profuse hæmorrhage; and it was particularly observed by the French surgeons in the lungs of individuals who were executed by the guillotine.*

Upon or near the surface of the lung we may observe circumscribed blackish or brownish spots, which do not in any degree depend upon the blood, since they are seen in the palest lungs. They present every variety, both in number and size, and generally increase with age. The source of these discolorations is not exactly known. Some consider them as deposits of minute particles of carbon which have been inhaled with the air; others, as produced by some chemical change which the air undergoes.

139. *Trachea.*—This is a partly membranous and partly cartilaginous tube, which proceeds from the larynx opposite the fifth cervical vertebra, descends perpendicularly into the chest, and divides about the level of the third dorsal vertebra into two tubes, called the right and left bronchi, one for each lung. Its length is from 4 to 4½ inches. Its diameter is about 8 or 10 lines in the adult, but it varies according to the age of the individual and the natural volume of the lungs. It is surrounded by an abundance of loose cellular tissue, and is freely moveable upon the adjacent parts. The tube is preserved constantly open by a series of carti-

* Bichat, Anat. descript. tom. iv. p. 12.

laginous rings, from sixteen to twenty in number, which extend round two-thirds of its circumference. At the posterior part of the tube the rings are deficient. This peculiarity at the back of the trachea has been ascribed to the situation and motions of the œsophagus; but this explanation cannot be admitted, since the same peculiarity exists in the bronchi. It is probably for the purpose of allowing a certain amount of variation in the diameter of the trachea; and this is the more likely, because the membranous part of the tube is provided with muscular fibres which can approximate the ends of the cartilages.

140. *Bronchi.*—The two bronchi differ in their length, direction, and diameter. The right is much shorter than the left, and passes more horizontally outwards to the root of its lung. In accordance with the larger dimensions of the right lung, the right bronchus is larger, in all its diameters, than the left; and this is the reason why foreign bodies which have accidentally dropped into the trachea are more likely to be carried into the right bronchus by the stream of the air. The same reason also accounts for the fact that at birth the right lung is inflated before the left. The left bronchus is about two inches in length, and descends more obliquely to its lung than the right.

At the root of the lung each bronchus divides into two branches, an upper and a lower, corresponding to each of the lobes of the lung; and on the right side the lower branch sends off a small division to the third lobe. The tubes diverge in all directions through the lung, and divide into branches, successively smaller and smaller, until they ultimately lead to the air-cells. These ramifications do not communicate with each other, and so far they are like the branches of a tree; hence it is that when any bronchial tube is closed or obstructed, all supply of air is cut off from the tubes and cells to which it leads.

The several tissues, *i. e.* cartilaginous, fibrous, muscular, mucous, and glandular, which collectively compose the air-passages, are not present in equal proportions throughout all their ramifications, but each is placed in greater or less amount in particular parts, according to the function which they have to perform. The cartilaginous rings, for instance, so obviously necessary to keep the larger

bronchi permanently open, become in the smaller tubes fewer and less regular in their form: as the subdivisions of the tubes multiply, the cartilages consist merely of small pieces placed here and there at intervals,—they become less and less firm, and finally disappear altogether; so that the air-passages, when so small as to be no longer traceable by the naked eye, are entirely membranous.

The *cartilages* of the trachea vary in number from sixteen to twenty; those of the right bronchus from six to eight; those of the left from nine to twelve. They form about two-thirds of a circle, and are somewhat compressed laterally, resembling a horse-shoe in form. Of the tracheal cartilages, some present peculiarities; those at the upper, and less frequently at the lower part of the tube, often divide near their extremities into two fork-like branches; and whenever this happens the opposite end of the next cartilage divides in a similar manner, so that there may be no interruption to the parallel arrangement of the successive series of rings. The lowest cartilage, situated at the bifurcation of the trachea, is shaped somewhat like the letter V; its angle projects into the centre of the main tube, and its sides belong one to each bronchus.

The cartilages are connected together, and to a certain extent covered both on the outer and inner surfaces by a tough membrane, consisting of fibrous and yellow elastic tissue. This membrane is attached to the circumference of the cricoid cartilage, and is continued through the whole extent of the trachea and the bronchial tubes. Posteriorly, where the cartilages are deficient, it alone maintains the integrity of the tube; in this situation, more especially, it consists of parallel and closely arranged longitudinal fibres, which are seated immediately beneath the mucous membrane, and raise it into more or less prominent folds. The elasticity of this structure admits of a certain degree of elongation of the trachea during the act of deglutition, and subsequently enables it to recover its ordinary length.

Glands.—On the outer surface of the membranous part of the trachea and bronchi are observed a number of small roundish glands of a light brown colour, of which the minute excretory ducts open into the tube. These little glands gradually diminish

in size in proportion to the size of the tubes. Their secretion, in a healthy state, is clear, very little tenacious, and just sufficient in quantity to lubricate the air-passages. Under ordinary circumstances it insensibly evaporates, but under circumstances of disease it is altered both in colour and consistence, and is poured out so abundantly that it excites a cough.

Muscular fibre.—After removing the glands and the fibrous membrane from the back of the trachea, we expose a thin uninterrupted stratum of pale muscular fibres which extend transversely between the cartilages, and are attached to their extremities; consequently, by their contraction, they will approximate the ends of the cartilages, and so diminish the calibre of the tube. These muscular fibres, not being under the influence of the will, are destitute of striæ.

The *mucous membrane* lining the air-passages is a continuation from that of the larynx. Its consistence is most marked in the trachea; in the bronchi it is more delicate, and its delicacy increases as the tubes divide. Its colour in the natural state is nearly white, but in catarrhal affections it becomes bright red, in consequence of accumulation of blood in the capillary vessels. Its surface is lined by a layer of epithelium of the ciliated kind, of which the vibratile movement is directed in such a way as to favour the expectoration of the mucus. By a recent observer* it is stated that the mucous membrane ceases at the commencement of the air-cells; and this is probably true, since no ciliated epithelium can be detected in them.

141. *Lobules of the lung.*—If we examine the surface of a healthy lung, we observe that it is mapped out, so to speak, by whitish lines, circumscribing spaces of various form and size. These spaces indicate the lobules of the lung. Now each lobule may be considered as a lung in miniature, so that any one who understands the structure of a single lobule understands the structure of the entire lung. The lobules are all connected together by a loose and fine cellular tissue, called "interlobular," which is everywhere soft and elastic to allow the free expansion of the organ. Its cells

* Rainey, Med.-Chir. Trans. vol. xxviii. 1845.

have no communication with the air-vesicles unless the latter be ruptured by excessive straining, and then this intermediate tissue may become inflated with air, and thus give rise to the form of disease called "interlobular emphysema." It is also in some cases rendered more obvious by being the seat of a serous effusion, constituting "anasarca" of the lungs.

Each lobule receives a small bronchial tube proportionate to its size, which divides and subdivides in its substance into smaller branches. Thus minutely reduced in size, the walls of the tubes no longer present any traces of cartilaginous tissue, but are composed of a delicate elastic membrane upon which the capillaries ramify in a very minute network. Each tube finally leads into an irregular passage, from which proceed on all sides numerous and closely arranged dilatations or sacculi: these are the air-cells. The cells themselves present a number of shallow depressions, separated by somewhat prominent partitions, so that their interior surface has rather a honeycomb appearance. The purpose of this is evidently to increase the extent of surface upon which the capillaries may ramify; and it is interesting to know that the structure of the minute air-cell of the human lung is in all respects similar to the large respiratory sac of the reptile.

142. *Pulmonary vessels.*—The branches of the pulmonary artery successively divide and subdivide in company with the bronchial tubes, inosculating very little in their course. Their ultimate ramifications spread out in such vast profusion over the air-cells, that when successfully injected the lung appears a mass of the finest network of blood-vessels. This network is so close that the interstices are even narrower than the vessels, which are on an average about $\frac{1}{3000}$th of an inch in diameter. It need scarcely be mentioned that the blood and air are not in actual contact. Nothing, however, intervenes but the wall of the cell and the capillary vessel, the which structures are so delicate as to oppose no obstacle to the free interchange of gases by which the blood is purified. The most complete purification of the blood takes place in that single layer of capillaries which is situated in the folds of membrane projecting into the cell; for it must be obvious that in this situation both sides of these vessels are exposed to the action of the

air. The blood, having been thus circulated in steady streams through this capillary plexus, returns through the pulmonary veins. These, at first extremely minute, gradually coalesce into larger and larger branches, which accompany those of the artery, and finally emerge from the root of the lung by two large trunks which carry the pure florid blood to the left auricle of the heart.

From this outline of the anatomy of the lung, we see that the organ is so constructed as, in a given space, to allow the largest possible quantity of impure blood to be brought in communication with the largest possible quantity of atmospheric air. Physiologists have attempted to calculate the extent of surface afforded by the air-cells collectively; and it has been estimated that in one lung only it would represent a superficial area of one thousand square feet. Without attaching much faith to the accuracy of such calculation, it is certain that the extent of surface must be very great, and it is difficult to conceive how any apparatus could be more admirably adapted to the object in view. A stratum of blood of great superficial extent is exposed to an equal stratum of air, and these strata of contiguous fluids are contained in the interior of an organ so small as to lie within the compass of the chest.

143. *Bronchial vessels.*—These are small arteries, two or more in number for each lung. They arise from the aorta (see § 121), and enter the lung in company with the divisions of the bronchi. They are the proper nutritive vessels of the organ. On this account the old anatomists called them the "vasa privata pulmonum," to distinguish them from the "vasa publica pulmonum"—namely, the pulmonary arteries. The former provide "pro existentia privata pulmonum;" the latter "pro bono publico totius organismi." The bronchial vessels are distributed in various ways; some of their branches supply the coats of the air-passages and the large blood-vessels, others the interlobular cellular tissue, and a few reach the surface of the lung, and ramify beneath the pleura.

Nerves.—The nerves of the lung are derived from the pneumogastric and the sympathetic. They enter the organ in company

with the bronchial tubes. It is stated by a German anatomist* that they may be traced to the surface of the lung and the pleura; but we have not hitherto succeeded in following them so far.

Absorbents.—The absorbents of the lung form a network upon its surface and in the interlobular spaces. They all pass through the bronchial glands. Of these, the larger are situated about the bronchi near the root of the lung; a few small ones are contained within the substance of the lung.

DISSECTION OF THE PHARYNX.

The most convenient mode of obtaining a view of the pharynx is to make a transverse incision through the trachea, œsophagus, and the great vessels on either side of the neck, and then to draw these parts forwards, so as to separate them from the bodies of the cervical vertebræ, to which they are but loosely connected by cellular tissue. The head should be removed at the first vertebra; and thus the pharynx and larynx will be left attached to the basis of the skull. A moderate quantity of horse-hair or tow may be introduced through the mouth and the œsophagus in order to distend the posterior wall of the pharynx. The head should then be placed on the face, and maintained in this position by hooks, so that we may commence the dissection of the parts from their posterior aspect.

144. The term Pharynx is applied to a dilated portion of the alimentary canal, which receives the food after it has undergone mastication in the mouth; and, by the movement of deglutition, propels it onwards into the œsophagus. It also serves as a medium through which atmospheric air passes into the trachea. It forms a sort of elongated muscular bag, which is firmly attached to the basilar process of the occipital bone, and from thence extends perpendicularly to the level of the lower border of the cricoid cartilage, where it terminates in the œsophagus. The bag is connected behind to the bodies of the cervical vertebræ by an abundance

* Remak, Med. Zeit. der Verein. f. Heilk. in Preussen. 1840.

of loose cellular tissue in which we never observe any fat, for the obvious reason that such a substance would impede its functions. Parallel with its sides run the great vessels of the neck. The dimensions of the channel are not equal throughout. Its breadth at the upper part is just equal to the space left between the inner pterygoid plates of the sphenoid bone, for here it is only required to transmit the air inspired through the nose; but it becomes much wider in the situation where it transmits the food—that is, immediately below the back of the mouth: and from this it gradually contracts to the œsophagus. The pharynx, therefore, may be rudely compared to a funnel communicating in front by wide apertures with the nose, the mouth, and the larynx; while the œsophagus represents the tube leading from its lower end. The upper part of the funnel forms a cul-de-sac at the basilar process of the occipital bone; there is here, however, a narrow orifice on either side, kept permanently open by the cartilaginous nature of its walls: it leads to a passage called the Eustachian tube, through which air is conveyed to the tympanum of the ear.

It may be observed that the pharynx conducts to the œsophagus by a gradual, not a sudden, contraction of its channel. This transition, however, is in some cases sufficiently abrupt to detain a foreign body, such as a morsel of food more bulky than usual, at the top of the œsophagus. If such an extraneous substance become firmly impacted in this situation, one can readily understand that it will not only prevent the descent of food into the stomach, but that it may occasion, by its pressure on the trachea, alarming symptoms of suffocation. Supposing that the obstacle can neither be removed by the forceps, nor pushed onwards into the stomach by the probang, it may then become necessary to extract it by making an incision into the œsophagus on the left side of the neck.

145. *Pharyngeal fascia.*—Before we can examine the stratum of muscular fibres which constitutes the posterior wall of the pharynx, we must remove from its surface a tolerably compact layer of condensed cellular membrane, which has been called, by some anatomists, the *pharyngeal fascia.* There can be no objection to this specific name provided, we understand that it is only a layer

of the cervical fascia placed between the muscles of the pharynx and the spine: and it must not be confounded with the proper pharyngeal aponeurosis which will be presently described. We may observe that it is firmly attached to the basilar process of the occipital bone, and to the point of the petrous portion of the temporal; that, on either side, it is continuous with the buccal fascia, the stylo-hyoid ligament, and the sheath of the great vessels of the neck: below, it is gradually lost upon the œsophagus.

On either side of the back of the pharynx, near the base of the skull, there are usually found two or more oblong absorbent glands of variable size. These it is necessary to remove without injury to the great vessels and nerves adjoining them.

146. *Pharyngeal venous plexus.*—In removing the fascia from the pharyngeal muscles, we should notice that a number of veins ramify and communicate in all directions upon their surface. They constitute the pharyngeal venous plexus of authors, and terminate in the internal jugular.

147. *Constrictor muscles of the pharynx.*—They are three in number, and are arranged so that they successively overlap each other, —*i. e.* the inferior overlaps the middle, and the middle the superior. They have severally the same attachments on both sides of the body; and the fibres from the right and left sides meet together in the middle, the junction being marked by a white longitudinal line called the raphé.

a. Inferior constrictor.—This arises from the side of the cricoid cartilage, from the inferior cornu and back part of the ala of the thyroid. Its fibres proceed backwards and expand over the lower part of the pharynx. The superior portion ascends obliquely, and terminates about the middle of the bag in a pointed form: the middle is more transverse, and the inferior slightly descending is closely united to the muscular covering of the œsophagus. Beneath its lower border the recurrent laryngeal nerve enters the larynx.

b. Middle constrictor.—This muscle arises from the upper edge of the greater cornu of the os-hyoides, and even from its lesser cornu and part of the stylo-hyoid ligament. Its fibres pursue different directions, so that with the opposite muscle they form an exact lozenge figure. The lower angle of the lozenge is covered

by the preceding muscle; the upper angle ascends nearly, if not quite, to the basilar process of the occiput, and terminates upon the pharyngeal aponeurosis. The external surface of the muscle is covered at its origin by the hyo-glossus, nothing intervening but the lingual artery.

c. Superior constrictor.—The origin of this muscle is rather complicated, and almost requires an express dissection for the purpose of displaying it. It arises from the lower half of the internal pterygoid plate, and from the hamular process of the sphenoid bone; from the so-called pterygo-maxillary ligament, by means of which it is connected with the buccinator; from the extremity of the mylo-hyoid ridge of the lower jaw, and from the side of the base of the tongue. The fibres pass inwards, running nearly parallel, to the mesial line, in which situation some of them are inserted through the pharyngeal aponeurosis into the basilar process of the occiput.

The upper border of the superior constrictor is thin and pale, and presents on either side of the mesial line a semilunar curve with its concavity upwards, so that between it and the base of the skull a space is left in which the muscular stratum is deficient. But here the pharynx is strengthened and walled in, as it were, by its own proper aponeurosis. The space is sometimes called the "*sinus of Morgagni*;" and in it, with a little dissection, may be exposed the muscles which raise and tighten the soft palate. We may observe that the fibres of the stylo-pharyngeus (see § 86) pass between the superior and middle constrictors, and expand upon the side of the pharynx; some of them mingle with those of the constrictors, but the majority are inserted into the posterior margin of the thyroid cartilage.

148. *Pharyngeal membrane* or *aponeurosis.*—Reflect the superior constrictor from the mesial line in order to obtain a view of the dense membrane, sometimes called the pharyngeal aponeurosis, which intervenes between the muscles and the mucous membrane of the pharynx. Notice the large number of mucous glands which are situated upon the surface of the membrane, especially near the base of the skull, and the orifice of the Eustachian tube. This membrane is the medium through which the pharynx is attached

to the basilar process of the occiput, to the point of the petrous portion of the temporal bone, and to the internal pterygoid plate of the sphenoid. It maintains the strength and integrity of the sac at its upper part, where the muscular fibres are deficient; but it gradually diminishes in thickness as it descends, and is finally lost near the œsophagus. One can easily understand why the pharynx should be deprived of its muscular coat opposite the posterior openings of the nose. The sac in this situation is never required as a passage for food, but only for air into and out of the lungs, and therefore must its channel be ever wide and open.

149. The pharynx must now be laid open by a longitudinal incision extending along the whole length of its posterior surface; we shall then observe the several openings which lead into its cavity:—1. The posterior openings of the nares. 2. On either side of them, near the posterior extremity of the lower turbinated bones, are the openings of the Eustachian tubes: below the nares is the soft palate, from the centre of which descends the uvula. 3. Below the soft palate is the communication with the mouth, commonly called the isthmus faucium. 4. On either side of this are two prominent folds of mucous membrane, constituting the anterior and posterior half-arches of the palate; and between them are placed the tonsils. 5. Below the isthmus faucium is the epiglottis, which is connected to the base of the tongue by three folds of mucous membrane. 6. Below the epiglottis is the wide aperture leading into the larynx.

The parts we are now about to examine are lined by the same mucous membrane which is common to the entire tract of the respiratory passages and the alimentary canal. This membrane presents more or less characteristic differences in the different parts of these channels, according as they are intended as passages for air or for food. For instance, the mucous membrane lining that part of the pharynx which is situated above the velum palati, being intended to transmit air only, is very delicate in its texture, and lined by a ciliated epithelium like the rest of the air-passages. But in that part opposite the fauces, the mucous membrane in every respect resembles that of the mouth, and is provided with squamous epithelium. At the back of the larynx we observe that

the membrane is corrugated into folds, evidently for the purpose of allowing the free expansion of the pharynx during the passage of the food.

The surface of the membrane is always lubricated by a plentiful secretion from the numerous mucous glands which are situated in the submucous tissue throughout the whole extent of the pharynx. These, we have already had occasion to notice, are particularly numerous and large in the neighbourhood of the Eustachian tubes.

150. *Posterior openings of the nose.*—These are two large and somewhat oval apertures leading into extensive and irregularly defined cavities, increased by many excavations in the neighbouring bones. They are divided into two lateral halves by a perpendicular septum. They are bounded above by the body of the sphenoid bone, externally by its pterygoid plate, below by the horizontal portion of the palate bone, and they are separated from each other by the vomer. Through these apertures the atmospheric air is constantly streaming in and out of the pharynx in its passage to and from the lungs.

151. *Isthmus faucium.*—This name is given to the opening by which the mouth communicates with the pharynx. If we look into the throat of a living person, we may observe that this aperture is bounded by the soft palate and uvula above, below by the root of the tongue, and on either side by the arches of the palate, enclosing the tonsils between them. The size and shape of this aperture admits of great variation, and we shall presently find that it may be completely closed by the contraction of its lateral boundaries.

152. *Soft palate*—This is a moveable prolongation of the roof of the mouth, attached to the posterior border of the hard palate. It constitutes an imperfect diaphragm or septum, interposed between the mouth and the posterior openings of the nose. Its upper or nasal surface is convex, and continuous with the floor of the nose; its lower surface is concave, in adaptation to the back of the tongue, and is marked in the mesial line by a prominent white ridge, indicating its original formation by two lateral halves. The general shape and direction of the soft palate may be easily seen by looking into the mouth: we may then observe that, anteriorly, it has

nearly the same horizontal direction as the hard palate to which it is attached; but it gradually becomes more curved as it passes backwards, decreasing at the same time in thickness, so that the free posterior border hangs loosely into the pharynx. Hence the name velum pendulum palati.

153. *Uvula.*—The soft palate presents posteriorly an elongated pendulous body projecting exactly from the middle line, and named the uvula. It causes the appearance of a double arch in the palate. Its length varies in different individuals and in the same person at different times, according to the state of its little elevator muscle. It occasionally becomes permanently elongated, and may then be the cause of considerable irritation, sufficient to occasion a sensation of tickling in the throat, and excite a harassing cough. This elongation of the uvula is sometimes so considerable that it is necessary to remove a portion. An instance is recorded* in which the uvula attained such an unusual length that it was bitten off by the patient in a fit of coughing.

154. *Arches of the palate.*—The soft palate is continued on either side into the tongue and pharynx by two folds of mucous membrane enclosing muscular fibres. These are called respectively the anterior and posterior half-arches or pillars of the palate. The anterior arch describes a curve from the base of the uvula, outwards and downwards to the side of the tongue. It is best seen by protruding the tongue. The posterior arch, commencing at the side of the uvula, curves outwards and backwards along the free margin of the velum, and terminates on the side of the pharynx. The posterior are the smaller, and when the tongue is depressed can be readily seen through the span of the anterior. The tonsils are situated on each side between these arches. We would especially direct attention to the plan upon which the soft palate and its arches are arranged, because a correct knowledge of them is essential to a right understanding of the respective function which each performs in the act of deglutition. We shall presently find that the posterior arches can approximate so as to close the

* Handbuch der topog. Anat. von Prof. Hyrtl. Bd. i. S. 283.

communication with the posterior nares during deglutition and vomiting. It is true that in vomiting food does sometimes escape through the nostrils, but one cannot wonder at this, considering the violence with which it is driven into the pharynx. The use of the soft palate is very manifest when it is partially lost by ulceration. Before, however, we touch upon this subject, it is well to examine the muscles which act upon the soft palate—namely, the levator and the tensor palati: after these, the muscles which act upon the arches.

155. *Muscles of the soft palate.*—The palate should be rendered tense by drawing down the uvula, and the mucous membrane should be removed from its upper surface. Beneath the mucous membrane will be discovered a plentiful supply of mucous glands *(glandulæ palatinæ)*, which pour out a copious secretion through numerous pores upon the surface. A considerable number are scattered all round the uvula. It will be necessary to remove these glands before we can display the muscles which expand the sides of the palate.

a. Levator palati.—This muscle is situated at the side of the posterior openings of the nose. It arises from the point of the petrous portion of the temporal bone in front of the carotid canal, and from the inner side of the cartilage of the Eustachian tube. It passes downwards and forwards, and expands upon the upper surface of the soft palate, joining more or less with its fellow in the mesial line. Some of its fibres descend into the wall of the pharynx. Its action is implied by its name.

b. Circumflexus or *tensor palati.*—This is a long flat muscle situated between the internal pterygoid muscle and the internal pterygoid plate of the sphenoid bone. It arises from the so-called scaphoid fossa at the base of the pterygoid process, and from the outer surface of the Eustachian tube. From this origin it descends perpendicularly, and ends in a tendon which turns round the hook of the pterygoid process at nearly a right angle, and then expands into a broad aponeurosis; this is not only connected to its fellow of the opposite side, but is also attached to the horizontal plate of the palate bones: upon it depends the chief strength of the soft

palate. To facilitate the play of the tendon round the hamular process, there is provided a synovial membrane. The *action* of this muscle is to draw down the soft palate and extend it laterally.

c. *Ayzgos* or *levator uvulæ.*—This consists of one or sometimes two thin bundles of muscular fibre, which arise from the aponeurosis of the palate, and descend along the posterior surface of the uvula nearly down to its extremity.

d. *Palato-glossus* and *palato-pharyngeus.*—These muscles consist of thin strata of fibres, contained within the membranous folds or arches which are continued from the soft palate to the tongue and pharynx. The palato-glossus, situated within the anterior arch, proceeds from the anterior surface of the soft palate to the side of the tongue, and is lost in the stylo-glossus muscle. The palato-pharyngeus, contained within the posterior arch, proceeds from the posterior border of the palate to the side of the pharynx, where it mixes with the fibres of the constrictor and the stylo-pharyngeus muscles.

In favourable subjects we may sometimes succeed in tracing the fibres of the palato-pharyngeus along the upper surface of the soft palate; some above, and others below the levator palati as far as the bone.

156. *Tonsils.*—The tonsils consist of an aggregation of muciparous glands, and they are situated on either side of the entrance of the fauces, in the interval between the anterior and posterior half arches of the palate. Their purpose here is to lubricate the isthmus during the passage of the food, and it is probable that the muscles between which they are situated squeeze out the fluid from their excretory ducts in the act of deglutition. The orifices of these ducts, visible on the surface, give the tonsil a perforated appearance not unlike the shell of an almond. From this circumstance, as well as from their general oval figure, they are called the "amygdalæ." These openings sometimes lead into small cells excavated in the substance of the tonsil, and lined by mucous membrane; and into these, numerous smaller ducts pour their secretion, for which the cell would seem to be a reservoir. The fluid, viscid and transparent in the healthy state, is apt to become white and opaque

in inflammatory affections of the tonsils, and occasionally accumulates in these superficial cells, giving rise to the deceptive appearance of a small ulcer, or even a slough in the part.

In respect to the position of the tonsil, it is very essential to bear in mind that it lies in front and to the inner side of the internal carotid artery. It is only separated from this great vessel by the superior constrictor and the dense membrane of the pharynx. Therefore, in removing a portion of the tonsil when enlarged, or in making an opening for the discharge of matter in cases of "cynanche tonsillaris," the point of the instrument should never be directed outwards, but rather inwards and backwards towards the mesial line. Cases are related by Portal and Béclard in which the carotid artery was punctured in opening an abscess in the tonsil. The result was immediately fatal hæmorrhage.

157. *Eustachian tube.*—This is a canal which conveys air from the pharynx to the tympanum of the ear. The orifice of it is situated opposite the posterior part of the inferior spongy bone, and is kept permanently open by a piece of elastic fibro-cartilage. The direction of the tube from the pharynx is upwards, backwards, and outwards, and it is about an inch and a half in length. Near the tympanum its walls are osseous, but towards the pharynx they are composed of fibro-cartilage and a dense fibrous membrane. At present we cannot see more than the cartilaginous orifice of the tube. It projects between the origins of the levator and the tensor palati, and gives attachment to some of the fibres of each, so that we must remove them in order to obtain a good view of the cartilage. This is situated at the base of the skull, in the furrow between the petrous portion of the temporal and the great wing of the sphenoid bone. It adheres closely to this bony furrow, as well as to the fibro-cartilage filling up the foramen lacerum medium in basi cranii, and to the inner margin of the scaphoid fossa. The orifice is not trumpet-shaped, as usually described, but of a compressed oval form, with the long axis nearly perpendicular. The fibro-cartilage bounds it only on the inner and the upper part of the circumference; the integrity of the canal externally is maintained by a tough fibrous membrane.

The tube is lined throughout by a continuation from the mucous

membrane of the pharynx, and is covered by a ciliated epithelium. For this reason, inflammatory affections of the throat or tonsils are very liable to be attended with more or less deafness, in consequence of the temporary obstruction they create in the Eustachian tube.

A number of mucous glands are sometimes aggregated into a mass like a second tonsil around the orifice of the tube. They are similar in their nature and function to the glands which lie in such profusion beneath the mucous membrane of the mouth, the palate, and the pharynx.

158. The *hard palate,* formed by the horizontal plates of the superior maxillary and palate bones, serves as a fulcrum for the tongue in the act of tasting, in mastication, in deglutition, and in the articulation of sounds. The tissue covering the bones is thick and close in its texture, and firmly united to the asperities on the bones themselves. But it is not everywhere of equal thickness. Along the raphé, observable in the mesial line, it is very much thinner than elsewhere, and more immediately connected to the periosteum; and this is probably the reason why the hard palate is in this situation more prone to be perforated by syphilitic disease.

By dissecting away the mucous membrane we shall discover a thick layer of glands *(glandulæ palatinæ)*, arranged in regular rows on either side of the hard palate. These glands become more numerous and larger as we approach the soft palate. Their orifices are generally visible to the naked eye; but two of them, more distinctly marked than the rest, are situated near the back of the palate, one on either side of the mesial line. The mucous membrane has a very thick epithelial coat, to which the white colour of the palate may be ascribed.

The descending palatine artery, a branch of the internal maxillary, and the corresponding palatine nerves from the spheno-palatine ganglion, may be traced from their bony canals along either side of the roof of the mouth towards the incisor teeth, behind which a delicate inosculation takes place between the arteries of opposite sides. The numerous ramifications of these arteries and nerves are destined to supply the soft as well as the hard palate.

159. We cannot conclude this part of our subject without making

a few observations on the act of deglutition. This process would appear at first sight to be rather a difficult and complicated study, since it requires the concurrence of numerous parts and the co-operation of several rapid motions. But this difficulty vanishes if the anatomy of the parts concerned be properly understood. In the consideration of this subject the two main points to be noted are—1st, that the food is prevented from passing into the posterior orifices of the nose by the complete approximation of the posterior arches of the palate; 2dly, that it is prevented from passing into the glottis by the elevation of the larynx and the flapping down of the epiglottis, as well as by the simultaneous contraction of the proper muscles of the rima glottidis. All this takes place without our being able to prevent it. Having premised thus much we will describe the process more in detail. The food, having been duly masticated, is collected into a mass upon the back of the tongue; the lower jaw is closed in order to give a fixed point for the action of the muscles which elevate the os-hyoides and larynx; the food is then carried back through the fauces by the pressure of the tongue against the palate, at the same time that the pharynx is elevated and expanded to receive it.* Having passed the fauces, the food is prevented from ascending into the nasal passages by the complete approximation of the posterior palatine arches, which thus form a kind of temporary roof to the pharynx; it is prevented from returning into the mouth by the pressure of the retracted tongue; it cannot enter the larynx, because the glottis is elevated and protected under the root of the tongue; consequently, being forcibly compressed by the constrictors of the pharynx, the food will pass onwards into the œsophagus, where there is the least resistance.

On observing these successive actions, we find that the food passes with different degrees of rapidity through the different parts of its course, but most rapidly of all through the pharynx. The necessity of this is obvious, when we consider that the air-tube opening into the pharynx must necessarily be closed while the food passes

* The larynx being also elevated and drawn forward, a greater space is thus left between it and the vertebræ for the distension of the pharynx.

over it, and that the closure thus produces a temporary interruption to respiration. The progress of the food through the œsophagus is slow and gradual.

DISSECTION OF THE LARYNX.

Before he commences the dissection of the larynx, the learner should make himself familiar with the several cartilages which compose it, and with the ligaments by which they are connected. In other words, the frame-work of the larynx should be examined as it is usually seen in the dry preparation. We propose, therefore, to give an outline of this, including the os-hyoides.

160. The *os-hyoides,* so called from its resemblance to the Greek letter Upsilon, is situated between the larynx and the root of the tongue, and serves as a fixed point for the attachment of many of the muscles of the tongue. In the living subject it may be felt immediately below the symphysis of the jaw. Anatomists divide it into a body, two greater and two lesser cornua. The body is the thick strong central portion which we feel in front of the neck. Its anterior surface is convex, and marked by depressions for the attachment of muscles; its posterior concave surface corresponds to the epiglottis. The two greater cornua (right and left) project backwards for about an inch and a half, not quite horizontally but with a slight curve upwards, and they terminate in blunt extremities tipped with cartilage. In young subjects they are connected to the central part of the bone by fibro-cartilage; but this in process of years becomes ossified. The lesser cornua are connected, one on either side, to the point of junction between the body and the greater cornua, by means of a little fibrous capsule, lined by synovial membrane, so that it admits of a certain degree of motion. It is not much larger than a barley-corn, and the stylo-hyoid ligament is attached to its free extremity.

The os-hyoides is connected to the thyroid cartilage by means of several ligaments, all of which contain a large quantity of elastic tissue. There is:—1. The *anterior thyro-hyoid:* this proceeds from the notch of the thyroid cartilage to the upper and posterior

part of the body of the os-hyoides. In front of this ligament there is, in the perfect larynx, a bursa of considerable size, of which the use is to facilitate the play of the upper part of the thyroid cartilage behind the os-hyoides. 2. The right and left *lateral thyro-hyoid ligaments* extend between the extremities of the greater cornua of the os-hyoides and the ascending cornua of the thyroid cartilage. They often contain a little nodule of cartilage. The vacant space left in the dried preparation between the hyoid bone and the thyroid cartilage is closed in the recent state by the *thyro-hyoid membrane.*

161. *Cartilages of the larynx.*—The framework of the larynx is composed of five cartilages connected by elastic ligaments, and capable of being moved upon each other in different directions by appropriate muscles; the object of this motion being to act upon two elastic cords, called the vocal ligaments, upon which the voice essentially depends.

a. Thyroid cartilage.—This is so called* because it is a protection to the fine apparatus behind it. It consists of two lateral and perfectly symmetrical halves called the alæ, and united at a more or less acute angle in the mesial line, where they form a conspicuous prominence in the neck of the male, known as the "*Pomum Adami.*" This angular prominence presents a notch at its upper part, as if a portion had been sliced off from below upwards, in order that it might rise up with greater facility behind the os-hyoides in the act of deglutition. The outer surface of each ala is marked by an oblique line, which gives attachment to the sterno-thyroid and thyro-hyoid muscles. The inferior border is slightly arched in the middle, and on either side presents a convex prominence, which gives attachment to the crico-thyroid muscle. The superior border is nearly horizontal. The posterior border, directed towards the spine, is nearly vertical, inclining slightly towards the mesial line from above downwards. This border terminates above and below in a rounded projection called respectively the upper and the lower cornu. The upper is the longer, and directed obliquely backwards; the lower is articulated at its extremity to the side of the cricoid cartilage.

* Θυρεὸς, a shield.

b. Cricoid cartilage.—This cartilage, named from its resemblance to a ring,* is situated immediately below the thyroid. It is not exactly circular, being rather broader in the antero-posterior diameter. It is narrow in front, where it may be felt in the neck about one quarter of an inch below the thyroid cartilage; from this part, however, the upper border gradually rises, so that, posteriorly, the ring is a full inch in its vertical depth, and occupies part of the interval left by the alæ of the thyroid cartilage. In the middle of this broad posterior surface is seen a vertical ridge, on either side of which there is a superficial excavation for the origin of the crico-arytenoidei postici. On its upper part are two oval, slightly convex surfaces for the articulation of the arytenoid cartilages. In front, its upper border presents a broad excavation, to which the crico-thyroid ligament is attached. The lower border has a slightly undulating outline, and is connected by elastic membrane to the first ring of the trachea.

The thyroid is connected to the cricoid cartilage in front by the crico-thyroid membrane, and laterally by its two inferior horns. Between these two cartilages there is a perfect joint on either side, provided with a synovial membrane, and secured by ligaments. This joint permits the approximation of the adjacent borders of the thyroid and cricoid cartilages, and it deserves especial attention, because upon this movement the due degree of tension is given to the vocal cords.

c. Arytenoid cartilages.—These cartilages are situated, one on either side, at the back of the larynx on the top of the cricoid. When viewed in the fresh state, before the membranes and muscles have been removed, the space left between them bears some resemblance to the lip of a ewer,† and from this fancied resemblance their name is derived. Each is triangular in form, with the apex superiorly and slightly bent backwards towards the pharynx. Its posterior surface is concave, and gives attachment to the arytenoid muscle. Its base presents an oval surface, which articulates with the cricoid cartilage. This joint is perfectly formed, and capable of limited motion in all directions, something like that of the first

* Κρίκος, a ring. † Ἀρύταινα, a ewer.

joint of the thumb. In front of the base there is a projection which gives attachment to the vocal cord, and itself contributes to form a part of the boundary of the rima glottidis. At the outer and back part of the base there is another projection or a tubercle, into which certain muscles moving the cartilage are inserted; namely, the crico-arytenoideus posticus, and crico-arytenoideus lateralis. The apex of the cartilage is sometimes surmounted by one or more small cartilaginous nodules, called "*cornicula laryngis*."

162. *Cordæ vocales.*—These are two elastic cords, extending horizontally from the angle of the thyroid cartilage to the base of each of the arytenoid. From their anterior point of attachment they diverge as they pass backwards; and the space left between them is called the rima glottidis. We shall presently see that through the muscles which act upon the arytenoid cartilages these cords can either be approximated or removed from each other; in other words, the glottis can either be closed or dilated. When sufficiently tightened, and brought parallel to each other by means of certain muscles, the cords are made to vibrate by the stream of the expired air, and thus is produced the voice.

163. *Epiglottis.*—This is a piece of elastic fibro-cartilage, which projects over the upper part of the larynx like the flap of a valve. Its ordinary position is perpendicular, leaving the glottis free for the purposes of respiration; but during the elevation of the larynx in deglutition it becomes horizontal, falling so as to cover the glottis, and thus tends to prevent the entrance of food into the cavity. Its apex or lower part is attached by means of the *thyro-epiglottidean* ligament to the angle of the thyroid cartilage; it is also connected by another ligament *(hyo-epiglottidean)* to the os-hyoides.

The cartilages of the larynx resemble those of the ribs in structure. In the young they are dense and elastic, but they have a tendency to ossify as age advances. In very old subjects, the thyroid and cricoid cartilages are often completely ossified, and their interior presents an areolar tissue, containing oily matter, analogous to the spongy texture of the bones. The epiglottis is never ossified on account of its peculiar organization, resembling the cartilages of the ear and the nose.

We now pass on to examine the larynx in its perfect condition.

164. The *mucous membrane* lining the larynx presents a loose and wrinkled appearance, excepting in particular situations in the interior, and is connected to the subjacent structures by an abundance of fine cellular tissue, which admits of its being pinched up into large folds. This tissue is deserving of notice chiefly on account of the rapidity with which it is apt to become the seat of a serous or purulent effusion in acute inflammation of the larynx, and thus produce sudden and alarming symptoms of suffocation. From the root of the tongue to the epiglottis the membrane forms three folds already described. It covers and adheres closely to this cartilage, and is continued from it backwards on either side to the apices of the arytenoid cartilages, forming the aryteno-epiglottidean folds, by which the entrance into the larynx is bounded. Tracing it into the larynx we observe that the membrane becomes finer in texture and more adherent to the subjacent parts, especially over the vocal cords. In the natural state it is of a pale rose colour, and covered by an epithelium of the ciliated kind.

The mucous membrane of the larynx is remarkable for its acute sensibility. This is requisite to guard the glottis during the passage of the food, since all aliment must necessarily pass over the larynx. Under ordinary circumstances the glottis is closed during the act of deglutition ; but if, during this process, any one attempt to speak or laugh, the glottis opens, and may allow the food to go, as it is termed, the wrong way. So soon, however, as the foreign body touches the mucous membrane of the larynx, a spasmodic fit of coughing ensues in order to expel it.

Mucous glands.—If a portion of the mucous membrane be removed, it will be observed that the tissue beneath is studded with a profusion of mucous glands. An oblong mass of them may readily be felt in the aryteno-epiglottidean fold, and they are particularly numerous about the ventricles. That surface of the epiglottis which looks towards the tongue is abundantly provided with them, and some of them are imbedded in its substance. Their ducts pass through the epiglottis, and may be recognized as minute openings on its laryngeal aspect.

165. *Superior opening of the larynx.*—This is the opening by which the larynx communicates with the pharynx. It is rather triangular in outline; the front part, or base, is bounded by the epiglottis; the sides by the thyro-arytenoid folds; the apex presents the peculiar funnel-shape appearance from which the arytenoid cartilages derive their name.

166. *Inferior opening of the larynx,* or *rima glottidis.*—By looking down into the larynx another opening is observed, like a horizontal slit, in the middle line; this is the rima glottidis. It is bounded on either side by the true vocal cords, of which we have already spoken in the description of the dried larynx, and they are not inaptly called the lips of the glottis. On each side of the glottis we remark an elliptical hollow, like a little pocket; this is called the ventricle of the larynx, or "*sacculus laryngis.*" By passing the handle of the scalpel up into these cavities, we find that they lead into a sort of cul-de-sac, which ascends for a short distance by the side of the thyroid cartilage. These cavities are obviously intended to allow free space for the vibration of the vocal cords. Lastly, we have to observe what are called the superior vocal cords. These are merely the prominent folds, one on either side, which form the upper crescent-shaped boundaries of the ventricles; and they are often spoken of as the false vocal cords, because they have little or nothing to do with the production of the voice. They are composed of a certain quantity of elastic tissue, like the true vocal cords, but less in quantity; and they contain besides more or less fatty tissue, which the true ones do not. A more complete view of all these important parts will be presently exposed. We would now again direct attention to the circumstance that only about the anterior two-thirds of the boundary of the glottis is formed by the vocal cords, the posterior third being completed by the smooth side of the base of the arytenoid cartilages. A slight prominence in the outline of the glottis indicates the relative share taken by the ligament and the cartilage in its formation. When the glottis is at rest—that is, during tranquil respiration—its shape may be rudely compared to the head of a spear; but in speaking or singing it assumes what is called the vocalizing position—that is, the opening becomes narrower and its edges nearly parallel.

167. *Muscles of the larynx.*—The several muscles should next be examined, which, by moving the cartilages of the larynx upon each other, indirectly influence the width of the glottis and the tension of the vocal cords. They are aptly named after their respective attachments.

a. M. crico-thyroideus.—This musclei s situated on the front of the larynx. It arises from the front and side of the cricoid cartilage, ascends obliquely outwards, and is inserted into the inferior border of the ala of the thyroid, and frequently also into its inferior horn. *Action.*—When both the muscles of opposite sides contract, they directly approximate the adjacent edges of the cartilages. The anterior part of the cricoid being drawn upwards rotates, as it were, round an imaginary horizontal axis drawn through its articulation with the lower cornua of the thyroid; consequently its posterior part moves downwards and backwards to a greater distance from the thyroid. Now this movement cannot take place without increasing in a corresponding degree the tension of the vocal cords, because the arytenoid cartilages into which they are inserted necessarily follow the cricoid in its movement. That this approximation of the cricoid and thyroid cartilages does take place, any one who can sing may easily satisfy himself by placing his finger on the cricoid thyroid membrane whilst he runs through the gamut.

b. M. crico-arytenoideus posticus.—To see thismuscle it is merely necessary to remove the mucous membrane from the back of the cricoid cartilage. It is of very considerable size, and of a triangular form. It arises from the excavation observable on the posterior part of the cricoid cartilage, from which the fibres, converging, are inserted into the outer angle of the base of the arytenoid. *Action.*—The muscles of opposite sides, contracting together, dilate the glottis. Of this it is very easy to be satisfied by pulling the muscle in the direction of its fibres, and at the same time looking at the glottis.

c. M. arytenoideus.—This single muscle fill sup the interval between the back of the arytenoid cartilages. The fibres pass across from the concave surface of one cartilage to that of the other. Most of them are transverse, but some of the more superficial decussate like the letter X, running from the base of the one to the apex

of the other cartilage. *Action.*—By approximating the arytenoid cartilages, they assist in narrowing the glottis.

d. M. crico-arytenoideus lateralis.—Toexpose this muscle requires careful dissection. We must remove the crico-thyroid muscle, and cut away the lower part of the ala of the thyroid cartilage. It arises from the upper border of the side of the cricoid cartilage, proceeds upwards and backwards, and is inserted into the outer angle of the base of the arytenoid. *Action.*—By drawing the arytenoid cartilages inwards, the muscles of opposite sides assist in narrowing the glottis.

e. M. thyro-arytenoideus.—To expose this muscle requires the same dissection as the preceding. It arises from the lower third, more or less, of the angle of the thyroid cartilage: from thence its fibres take different directions. The greater part of them pass horizontally backwards, and are inserted into the front surface of the base of the arytenoid cartilage. This is the most important part of the muscle, so far as vocalization is concerned: its fibres run parallel with the vocal cord, and some of them are directly inserted into it. Another, but thinner, portion of the muscle ascends, spreading out over the ventricle of the larynx, and is inserted into the whole of the outer border of the arytenoid cartilage. We sometimes find an additional bundle of muscular fibres proceeding from the angle of the thyroid cartilage, near its notch, to the arytenoid near the base. *Action.*—Those fibres which run parallel with, and below, the vocal cords will place them in the vocalizing position, *i. e.* parallel to each other. Other fibres, by approximating the angles of the arytenoid cartilages, will tend to narrow the glottis.

f. M. thyro-epiglottideus.—Under this name, some anatomists have described a few slender muscular fibres which proceed, on either side, from the angle of the thyroid cartilage to the corresponding margin of the epiglottis. They are said to act as depressors of the epiglottis. Haller describes them as part of the thyro-arytenoideus. They are by no means generally found. The motions of the epiglottis are of a mechanical nature, and not performed by muscular action.

g. M. aryteno-epiglottideus.—This consists of a few pale muscular fibres, which are enclosed in the aryteno-epiglottidean fold of

mucous membrane. Some of them run near the free margin of the fold, others are found much lower down. These, being thinly distributed over the ventricle of the larynx, are able so to approximate its walls as almost to obliterate the cavity. Hence the name "compressor sacculi laryngis," given to this part of the muscle by the anatomist* who first drew attention to it.

The following table, taken from a paper by Professor Willis,† shews at a glance the action of the several muscles which act upon the glottis :—

Crico-Thyroidei	Stretch the Vocal Cords	Govern the pitch of the notes.
Thyro-Arytenoidei	Relax the Vocal Cords, and place them in the vocalizing position	

Crico-arytenoidei postici .	Open the glottis		Govern the aperture of the glottis.
Crico-arytenoidei laterales	Draw together the arytenoid cartilages	Together close the glottis	
Arytenoideus	Ditto Ditto		

The larynx should now be laid open by making a longitudinal incision along the middle of its posterior part. A complete view will thus be obtained of the true and the false vocal cords, and the ventricles between them. By carefully dissecting the mucous membrane from the lips of the glottis, we expose the elastic structure of the vocal cords; we notice also the thyro-arytenoideus muscle below them, the direction of its fibres, and the mode in which they are inserted. We see that they run parallel with the vocal cords, and that they are closely connected to them, so that the tendency of their action will be to bring the lips of the glottis parallel to each other, and consequently to place them in the vocalizing position.

168. *Vessels of the larynx.*—These are derived from the superior and inferior thyroid arteries. The laryngeal branch of the superior thyroid (see § 31, *b.*) passes through the thyro-hyoid membrane

* Hilton, Guy's Hospital Reports, Vol. ii.

† Cambridge Philosophical Transactions, 1832.

in company with the corresponding nerve, and divides into branches, which supply the muscles and the mucous membrane. The laryngeal branches of the inferior thyroid ascend behind the cricoid cartilage. A very constant artery passes through the crico-thyroid membrane to the larynx (§ 31, *d.*)

169. *Nerves.*—The nerves which supply the larynx are derived from the pneumogastric. There are the *superior* and the *inferior* or *recurrent* laryngeal. These we should respectively trace.

a. The *superior* laryngeal, having passed through the thyro-hyoid membrane, divides into several branches, which are distributed to the mucous membrane of the larynx, with this exception, that one of its filaments may generally be traced into the arytenoideus muscle. Its other filaments spread out in various directions; some to the anterior and posterior surfaces of the epiglottis, and to the aryteno-epiglottidean folds of mucous membrane, others to the interior lining of the larynx and the vocal cords. A very constant filament descends behind the ala of the thyroid cartilage, and communicates with the recurrent. Its external laryngeal branch, supplying the crico-thyroid muscle, has been described (§ 32, *a.*)

b. The inferior or recurrent laryngeal nerve, having entered the larynx beneath the inferior constrictor muscle of the pharynx, ascends behind the joint between the thyroid and cricoid cartilages. By careful dissection, we may succeed in tracing its filaments into all the intrinsic muscles of the larynx, with the exception of the crico-thyroid. It also gives a few to the lower part of the pharynx. If the recurrent nerve be divided, or in any way injured, the muscles moving the glottis become paralysed, but its sensibility remains unimpaired. In cases where the nerve is compressed by a tumor—say, for instance, an aneurism of the arch of the aorta—the voice may be changed to a whisper,* or even altogether lost.

170. *Difference between the male and the female larynx.*—Until the approach of puberty, there is no great difference in the relative size of the male and female larynx. The male larynx, within the space of two years after this time, becomes nearly doubled in

* Medical Gazette, Dec. 1843.

size; the female also grows larger, but in a far less proportion. This corresponds with the comparative change observed in the voice in each sex.

The larynx of the adult male is in all proportions about one-third larger than that of the adult female.

The alæ of the thyroid cartilage form a much more acute angle in the male; hence the greater projection of the "pomum Adami," and the greater length of the vocal cords, in the male.

The average length of the vocal cords is in the	Male.........	8 lines
	Female......	6 "
The average length of the glottis is in the......	Male.........	12 lines
	Female......	10 "

The size of the larynx does not necessarily follow the proportions of the general stature in either sex; it may be as large in a little person as in a tall one: and this corresponds with what we know of the voice.

171. *Crico-thyroid articulation.*—This little joint is provided with a capsule and synovial membrane. There are, besides, two ligaments, much stronger than might have been expected from the smallness of the joint. Both proceed from the cornu of the thyroid cartilage; the one upwards and backwards, the other downwards and forwards to the cricoid. The articulation between the arytenoid and cricoid cartilages has a loose capsular and synovial membrane, in accordance with the extensive range of its motions.

DISSECTION OF THE TONGUE.

The tongue, with the os-hyoides and larynx, should be removed from its several connexions in order that it may be examined apart from the body.

172. The tongue is a very complex muscular organ, subservient to the several purposes of taste, speech, suction, mastication, and deglutition. Its figure is so well known that it needs no description.

By means of muscles, it is connected to the symphysis of the jaw, to the os-hyoides, and to the styloid process of the temporal bone. To the soft palate it is connected by the anterior palatine arch (see § 154), and to the epiglottis by folds of mucous membrane; in the middle fold, there is enclosed a well-marked layer of elastic tissue, which may be called the "glosso-epiglottidean" ligament. This necessarily pulls up the epiglottis when the tongue is protruded from the mouth: hence the rule of never attempting to pass a tube into the œsophagus without having previously pushed back the tongue; otherwise the end of the tube would be very liable to pass into the larynx.

We should first direct our attention to the structure of the upper surface of the tongue—that is, its most sensitive apparatus; and next, to the structure of its interior muscular apparatus.

The upper surface of the tongue is composed of structures more or less similar to those of the skin generally; that is to say, it consists of a "cutis," or true skin, with numerous projections, called "*papillæ*," and of a thick layer of epithelium. The cutis is much thinner than that of the skin; it affords insertion to some of the more superficial muscular fibres of the tongue, and the blood-vessels form a close network in it before they pass into the papillæ.

173. The several papillæ on the tongue are distinguished, according to their size and form, into three kinds, viz. "*papillæ maximæ*, or *circumvallatæ*," "*papillæ fungiformæ*," "*papillæ filiformæ*."

a. The *papillæ circumvallatæ* vary in number from seven to twelve. They are arranged at the back of the tongue in two rows, which converge like the branches of the letter V, only with the apex backwards, towards the so-called foramen cæcum,—a blind pouch in the middle line of the tongue. Each of these papillæ is of a circular form, with a central depression, and is surrounded by a fossa, from which its name is derived: the fossa itself is also circumscribed by an elevated ring.

b. The *papillæ fungiformæ*, much smaller and more numerous than the preceding, are scattered irregularly over the whole of the upper surface and sides of the tongue. They vary in shape, some being cylindrical, others having heads to them, like mushrooms; whence their name. Near the apex of the tongue they may readily

be distinguished during life from the other papillæ by their redder colour; especially if the tongue be touched with any strongly tasting fluid, such as vinegar. They appear to shoot out under the action of the stimulus, and it is probable that the same effect always accompanies the sensation of taste. In scarlatina, and some exanthematous fevers, it is observed that these papillæ become remarkably elongated, and of a bright red colour; as the fever subsides, their points collapse, and acquire a brownish tint, giving rise to the appearance commonly known as "the strawberry tongue."

c. The *papillæ filiformæ* are the smallest and most numerous of all; they are so closely aggregated that they give the tongue a velvet-like appearance. The points are directed backwards, so that the tongue feels smooth, if the finger be passed over it from apex to base; but rough, if in the opposite direction.

All the papillæ are covered with a layer of tesselated epithelium. That which covers the filiform is very thick and dense in proportion to the rest, and with the aid of a microscope may be seen to project from their sides in a hair-like form. Some of these projections even resemble hair in structure.

Respecting the use of the papillæ, it may be stated that they enable the tongue to detect impressions with greater delicacy; and it would appear probable that they are severally instrumental in detecting different kinds of sensation, whether of taste or touch. In consequence of the peculiar density and arrangement of their epithelial coat, the filiform papillæ give the surface of the tongue a degree of roughness which is useful in its action upon the food. An apparatus of this kind, proportionately stronger and more developed, makes the tongue of ruminant animals an instrument of prehension by which they lay hold of their food. In the feline tribe, the lion and tiger for instance, these papillæ are so sharp and strong that they act like rasps, and enable the animal to lick the periosteum from the bones by a single stroke of his tongue. In some mammalia, too, they act like combs for cleaning the skin and the hair.

If the papillæ be well injected, and then examined under the microscope, it is found that they are none of them simple, like

those of the skin, but that each is composed of a multitude of secondary papillæ arranged in various ways: for instance, let a single "papilla circumvallata" be analysed, as it were, and we shall see that it consists of an aggregation of smaller papillæ arranged parallel to each other; again, a filiform papilla consists of a central stem or axis, from which minute secondary papillæ shoot off. This elaborate structure commonly escapes observation because it is buried beneath the epithelium.* Each secondary papilla receives a blood-vessel, which passes nearly to its apex and then returns in a loop-like manner. But the filaments of the gustatory nerve have not, hitherto, been traced beyond the base of the papilla.

174. *Lingual glands.*—Numerous small glands are found in the submucous tissue at the root of the tongue. They are similar in structure and secretion to the tonsillar and palatine glands, so that there may be said to be a complete ring of glands round the isthmus faucium. Small round orifices upon their surface indicate the termination of their ducts: many of these open into the foramen cœcum. Other mucous glands, with ducts from one quarter to half an inch long, are situated in the muscular substance of the tongue.

175. *Glands beneath the apex of the tongue.*—On the under surface of the apex of the tongue is placed on either side a group of glands which are presumed to be salivary. Considering each group as one gland, we observe that it is oblong, with the long diameter from seven to ten lines in length, and parallel with the long axis of the tongue. It lies about two lines from the mesial line, a little below the ranine artery, on the outer side of the branches of the gustatory nerve, and under some of the longitudinal fibres of the stylo-glossus. Four or five ducts proceed from each group, and terminate by separate orifices on the under surface of the tongue.

176. *Muscular fibres of the tongue.*—The interior of the tongue is composed of muscular fibre and of a small quantity of fat and cellular tissue. What may be called the extrinsic muscles of the tongue have been already described in the dissection of the sub-

* See Bowman and Todd's Physiological Anatomy.

maxillary region (see § 17). We have now only to examine its proper or intrinsic ones. For this purpose the mucous membrane must be removed from the surface of the tongue. It will then be obvious that the great bulk of the organ consists of a mass of fibres which proceed in a longitudinal direction from base to apex, constituting the "*linguales*" muscles. These fibres are not all of equal length; the more superficial are implanted into the skin covering the tongue, those deeply seated run all the way from base to apex; and these are readily exposed by dissecting on the under surface of the tongue immediately on the outer side of the genio-hyo-glossus muscle. By the action of this mass of longitudinal fibres the tongue can be curved in various directions, so as to reach any part of the mouth, according as this or that portion of the muscle contracts. But besides the linguales, there are muscular fibres intermingled variously in the tongue of which it is hard to give a description; and one cannot be surprised at this, considering the various and rapid motions of the organ.

If, now, we trace the genio-hyo-glossi of opposite sides into the tongue, we shall find that some of their fibres ascend directly to the surface; others cross each other in the middle line, and then turning outwards, intersect the longitudinal fibres, and finally terminate upon various points of the sides of the tongue. Lastly, the fibres of the stylo-glossus may be traced along the side of the tongue to the apex.

In the mesial line near the base of the tongue there may be found a vertical plane of fibrous tissue, which is connected behind to the body of the hyoid bone, and is lost in front between the muscles. This so-called "*nucleus fibrosus linguæ*" is but a feeble representative of the lingual bone which exists in some of the lower animals.

177. The several *nerves supplying the tongue* should be followed into its substance. The subdivisions of the hypoglossal nerve supply all the muscles with motor power. The ramifications of the gustatory or lingual branch of the fifth pair are distributed to the mucous membrane about the apex and sides of the tongue, and endow it with a most acute sensibility. Upon this nerve depends the sensation of all ordinary impressions, such as that of hardness,

softness, heat, cold, and the like; it is probably also a nerve of taste. The glosso-pharyngeal nerve supplies the mucous membrane at the back and sides of the tongue, but we have frequently succeeded in tracing one of its filaments to the apex. It is especially a nerve of taste.

DISSECTION OF THE SCALP.

An incision should be made from the root of the nose along the mesial line to the occiput; and another at right angles to the first from one side of the head to the other. These incisions must not divide more than the skin, in order that the subcutaneous vessels and nerves may not be injured.

178. To give a general outline of the subject, it may be well to state at once that the several strata of soft parts covering the skull-cap, are—1, the skin; 2, a thin substratum of tough adipose and cellular tissue in which the cutaneous vessels and nerves ramify, and by which the skin is very closely connected to, 3, the broad thin tendon of the occipito-frontalis muscle, called the aponeurosis of the scalp; 4, an abundance of loose cellular tissue, which permits the free motion of the scalp upon, 5, the pericranum, or periosteal membrane of the skull-cap.

179. Immediately beneath the skin, then, we expose the thin stratum of adipose and cellular tissue which connects it to the aponeurosis of the scalp. It forms a sort of bed for the bulbs of the hair. We notice that it cuts remarkably tough, and that, on this account, it is no easy matter to dissect out the subcutaneous vessels. This toughness and unyielding nature of the structure in which the arteries ramify does not readily permit them to retract when divided; hence the considerable hæmorrhage which commonly follows incised wounds of the scalp: hence, also, the difficulty of drawing them out with the forceps in order to tie them. The blood-vessels of the scalp are derived from several sources. In front, from the supra-orbital arteries; on the sides, from the temporal; behind, from the occipital and posterior auricular. It is

unnecessary to describe each of these in detail. Trace the leading trunks, and observe that they subdivide into branches, which inosculate freely, and finally form a vascular network among the bulbs of the hair. A few small branches here and there pass into the pericranium. The veins accompany the arteries.

180. *Occipito-frontalis muscle.*—This is a broad thin cutaneous muscle situated immediately beneath and closely connected to the scalp. It consists of two fleshy portions, one on the occiput, the other on the forehead, and the two are connected by a broad intermediate aponeurosis which extends over the roof of the skull. The origin or fixed point of the muscle takes place from the outer two-thirds, more or less, of the upper curve on the occipital bone, and the adjoining part of the mastoid process of the temporal. The fibres ascend over the back of the head, and terminate in the common aponeurosis. The anterior or frontal portion, commencing in an arched form from the common aponeurosis near the frontal suture, descends over the forehead, and terminates partly in the integument of the eyebrow, and partly in the orbicularis muscle. Those fibres near the mesial line descend along the root of the nose under the name of the "pyramidalis nasi" (see § 61). The aponeurosis of the scalp is continued over the temples and side of the head, gradually changing from tendinous into fibro-cellular tissue. *Action.*—This muscle enables us to move the scalp in a slight degree backwards and forwards. But its chief action is as a muscle of expression. It elevates the brows, and occasions those transverse wrinkles observed in the expression of surprise. Like the other muscles of expression it is supplied by the facial nerve.

181. *Muscles of the ear.*—There are several little muscles intended to move the cartilage of the ear. In the human subject these muscles are thin and pale, since the ear is very little moveable: but in animals who possess a more delicate sense of hearing they are much more developed, for the purpose of quickly directing the cartilage of the ear towards the pulse of the air.

a. M. attrahens aurem and *attollens aurem.*—These little muscles are both triangular in form, and are attached by their

bases to the aponeurosis of the scalp. The fibres of each converge, and are inserted, those of the former into the front of the helix, those of the latter into the back part of the concha.

b. M. retrahens aurem.—This is composed of one or more distinct bundles of fibres, which proceed from the base of the mastoid process to the lower part of the concha. All the muscles of the ear are supplied by the auricular branch of the facial nerve (see § 37).

182. *Nerves of the scalp.*—In order to dissect these nerves we should first find the principal trunks; and there is no difficulty in doing so, because they accompany the arteries.

a. Supra-orbital nerve.—This is a branch from the ophthalmic division of the fifth pair. It emerges from the orbit through the notch of the frontal bone, and subdivides into cutaneous branches. It will be observed that they are covered at first by the fibres of the orbicularis and occipito-frontalis muscles; but they presently become subcutaneous: some of them may be traced over the top of the head as far as the occipital bone.

b. Superficial temporal nerves.—These ramify in company with the arteries of the same name. Some of them are derived from the inferior maxillary, or third division of the fifth pair; others from the facial nerve (see § 77).

c. Posterior auricular nerve.—This nerve, a branch of the facial, will be found with its corresponding artery behind the pinna of the ear (see § 37).

d. Great occipital nerve.—This is the posterior branch of the second cervical nerve. After passing through the M. complexus, it appears on the back of the head in company with the occipital artery, and divides into wide spreading cutaneous branches. The *lesser occipital* nerve, a branch of the cervical plexus, (see § 5, *a*) may be found near the posterior border of the insertion of the sterno-mastoid.

183. If the aponeurosis of the scalp be raised, we observe the quantity of loose cellular tissue which intervenes between it and the pericranium. This tissue never contains fat. We would, however, draw attention to it chiefly for the reason, that after injuries of the head this tissue is very apt to become the seat of inflamma-

tion, constituting what is called phlegmonous erysipelas of the scalp. As a consequence of this, it soon becomes infiltrated with pus, and rapidly sloughs. Now we see at once the necessity of making incisions under these circumstances; the scalp will not lose its vitality and liberate the slough, like the skin does under similar conditions in other parts, because its subcutaneous nutrient vessels ramify above the diseased tissue, and are therefore altogether independent of it.

184. The *absorbent* vessels of the scalp run, most of them at least, backwards towards the occiput, where they enter the absorbent glands in that situation. Here, therefore, one commonly finds a glandular enlargement when the scalp is diseased.

185. The brain should now be removed in the usual manner. This organ, with its membranes, will be described in a subsequent part of this work. At present we propose to take a general survey of the nerves as they pass out of the base of the skull, and then to dissect the cavernous sinus and the orbit.

Exit of the nerves through the foramina at the base of the skull.—The cranial nerves proceed in pairs; that is, one on either side through the foramina at the base of the skull, and they are named—first, second, third, fourth pair, &c. &c., according to their order of succession from before backwards.

The *first pair* are the *olfactory nerves.* These cannot be seen, because the olfactory lobes are usually removed with the brain, and consequently torn away from the delicate olfactory nerves which pass through the cribriform plate of the æthmoid bone.

The *second,* or *optic nerve,* passes through the foramen opticum into the orbit.

The *third,* or *motor oculi,* is seen passing through the dura mater, close behind the anterior clinoid process.

The *fourth,* or *patheticus,* a very small nerve, passes through the dura mater a little behind the posterior clinoid process.

The *fifth,* or *trigeminal nerve,* passes through an aperture in the dura mater beneath the tentorium cerebelli, just above the point of the petrous portion of the temporal bone.

The *sixth* passes through the dura mater behind the body of the sphenoid bone.

The *seventh,* consisting of the *facial* and *auditory nerves,* passes through the meatus auditorius internus.

The *eighth,* consisting of the *glosso-pharyngeal, pneumo-gastric,* and *spinal accessory,* passes through the foramen lacerum jugulare. But these three divisions do not all pass through the same tube of dura mater; for the glosso-pharyngeal has a separate tube anterior to the other two, which have a common one.

The *ninth,* or *hypo-glossal nerve,* passes through the anterior condyloid foramen.

186. At the base of the skull, between the dura mater and the bone, are observed the ramifications of the arteria meningea media, with its two veins. This artery, a branch of the internal maxillary, (see § 82, A *b*) enters the skull through the foramen spinosum, and then divides into two principal branches; one of which runs in a groove, or perhaps a distinct canal, along the anterior inferior angle of the parietal bone; the other curves backwards over the temporal bone, and subsequently ramifies on the parietal. It supplies the dura mater and the bones. The position of these arteries obviously renders them very liable to be injured in fractures of the skull. As a result of their injury a more or less considerable extravasation of blood may take place between the dura mater and the bones, and occasion symptoms of compression of the brain.

Some notice must now be taken of the cavernous sinus, and of the nerves which course through its walls to the orbit; namely, of the third, the fourth, the first division of the fifth, and the sixth.

187. Cavernous sinus.—One among the many peculiarities of the cerebral circulation is, that the returning blood flows through fibrous canals formed by the dura mater, and called "*sinuses.*" The general anatomy, the course, as it is called, and the names of these several canals, will be considered with the anatomy of the brain. But the cavernous sinus, for reasons which will appear presently, should be examined immediately before the dissection of the orbit.

This sinus, then, is situated by the side of the body of the sphenoid bone; it extends from the apex of the petrous portion of the temporal bone, to the sphenoidal fissure at the back of the orbit, and here it receives the ophthalmic vein. There is a corresponding sinus on the opposite side, and the two are connected by small sinuses running transversely, one in front of, the other behind, the "sella tursica:" collectively, therefore, these several sinuses form the "circular sinus" properly so called.

In the substance of the outer wall of the cavernous sinus we must trace forwards to the orbit the third nerve, the fourth, and the first division of the fifth. On its inner wall we shall trace the sixth nerve, and (still nearer to the side of the sella tursica) the windings of the internal carotid artery. All these parts are said to be "contained in the cavernous sinus;" but it should be clearly understood that none of them are bathed in the blood of the sinus, because they are separated from it by the lining membrane. Having, then, traced the nerves through the outer wall of the sinus, we observe that they are placed in the following relative position: —The third lies the highest; the fourth lies immediately below the third, but crosses over it just as they enter the orbit; the sixth lies on the inner wall of the sinus, close to the carotid artery.

188. By removing the dura mater, and following the fifth nerve forwards, we find that its great sensitive root spreads out, so as to form an almost inextricable interlacement of nervous fibres, called the *semilunar*, or, after its discoverer, the "*Gasserian*" ganglion. From this ganglion proceed the primary divisions of the nerve; namely, the *ophthalmic*, which passes through the sphenoidal fissure; the *superior maxillary*, through the foramen rotundum; and the *inferior maxillary*, through the foramen ovale. The small motor root of the fifth lies beneath the ganglion, with which it has no communication, and accompanies the inferior maxillary division for the purpose of supplying the muscles of mastication.

189. *Curves of the carotid artery.*—After the removal of the cavernous sinus, a good view may be obtained of the two remarkable curves, just like the letter S, which are made by the carotid artery on the side of the sella tursica. The vessel enters the cranium at the

apex of the petrous portion of the temporal bone, makes its sigmoid curves, and then passes through the dura mater between the anterior clinoid process and the optic nerve: just in this situation it gives off the ophthalmic artery.

190. *Cavernous plexus.*—The superior cervical ganglion of the sympathetic sends up with the carotid artery two or more slender filaments, which form a plexus round it in its tortuous course through the petrous bone, and by the side of the sphenoid. After a careful dissection we may discover with the naked eye in this plexus very small ganglia called *carotid* or *cavernous:* but they vary in number, size, and situation. Through these nerves a communication is established between the sympathetic and many of the nerves which enter the orbit.

Presuming that the bony framework of the orbit and the several openings in it be thoroughly understood, we propose to examine its contents, in the order in which they appear, commencing from the roof of the cavity.

DISSECTION OF THE ORBIT.

191. The roof of the orbit should be taken off by two vertical cuts made with a fine saw; the one commencing a little on the outer side of the internal angular process of the frontal bone, in order to avoid injuring the beautiful little pulley there attached; the other a little on the inner side of the external angular process. With a bone forceps, the thin roof of the orbit should then be removed as far back as the optic foramen; and it is easy to do this without injuring the orbital periosteum, on account of its loose connexion with the bone.

192. *Periosteum of the orbit.*—The roof being removed, the first thing exposed is the thick fibrous membrane which lines the bony walls of the orbit. It is usually considered as a continuation of the dura mater through the optic foramen and the sphenoidal fissure. If it be traced forwards, we find that near the margin of the orbit it divides into two layers, one of which is directly con-

tinuous with the periosteum of the forehead, the other with the broad tarsal ligament which fixes the tarsal cartilages (see § 62, *d.*)

193. *Fascia of the orbit.*—Having divided and turned aside the periosteum, we discover a thin layer of condensed cellular membrane which invests the contents of the orbit, enclosing them collectively in a sort of capsule; this membrane may fairly be called the fascia of the orbit. It provides the lachrymal gland, and each of the muscles, with a loose sheath, which is thin and delicate near their origin at the back of the cavity, but gradually increases in strength as the muscles approach the eye. In this situation especially it passes laterally from one rectus muscle to the other, so that their insertions into the globe are, in a measure, connected by the membrane. From the insertion of the muscles it is reflected backwards over the globe of the eye, and for a short distance over the optic nerve, so that it separates the eye from the fat at the bottom of the orbit. It should be observed, however, that it is connected to the sclerotica by the intervention of fine and loose cellular tissue, which never contains fat, and serves to facilitate the free movements of the globe.

194. In order to give a general idea of the contents of the orbit, it may be as well to state that there are six muscles intended to move the eye; four of which, running in a straight direction, are called "*recti,*" and they are arranged respectively, one above, another below, and one on each side of the globe. The remaining two are called from their direction, "*obliqui,*" one superior, the other inferior, in respect to the globe. There is also a muscle to raise the eyelid. The several *nerves* are: the optic or proper nerve of vision, which passes through the optic foramen; the third, the fourth, the first division of the fifth, and the sixth, all of which pass through the sphenoidal fissure. The third supplies all the muscles with motor power, excepting the superior oblique, which is exclusively supplied by the fourth, and the external rectus which is exclusively supplied by the sixth. The ophthalmic division of the fifth is the sensitive nerve common to all parts in the orbit. It divides into a frontal, lachrymal, and nasal branch. The orbit contains, also, a considerable

quantity of soft fat, which is chiefly accumulated between the muscles at the back of the eye. This fat supports the eye in the orbit, and prevents it from being pulled too far back by its muscles. Upon the greater or less abundance of it depends, in some measure, the difference observed in the prominence of the eyes in different individuals. Its absorption in disease or old age occasions the sinking of the eyes. It has been already mentioned that the eye is separated from this fat by a fold of thin membrane, forming a kind of "tunica vaginalis," which enables the globe to roll freely upon the fat as upon a bed, and execute its motions with the greatest rapidity and precision. Lastly, the orbit contains the lachrymal gland.

After the removal of the periosteum, and the fascia of the orbit, the following parts are brought to view. In the middle we observe the *frontal* nerve, with its corresponding artery, lying upon the levator palpebræ superioris; on the inner side, there is the *superior oblique* with its nerve (the 4th); on the outer side, there is the *lachrymal* nerve and artery; and below them is the external rectus muscle. The lachrymal gland is also seen at the outer and front part of the orbit.

195. *Frontal nerve.*—This is one of the three principal branches into which the ophthalmic portion of the fifth divides. It enters the orbit in company with, but a little below, the fourth nerve. It runs directly forwards upon the upper surface of the levator palpebræ to the margin of the orbit, where it passes through the supra-orbital notch, and ascends to supply the forehead and scalp (see § 182, *a*). In this course it gives off the following branches:—

+ *a.* The *supra-trochlear* comes off from the frontal nerve within the orbit, proceeds forwards above the pulley of the superior oblique, emerges from the inner angle of the orbit, and divides into branches, which are distributed, partly to the upper eyelid, partly to the forehead and root of the nose. One or two very delicate filaments may sometimes be traced through foramina in the bone to the mucous membrane of the frontal sinuses.*

* These filaments have been noticed by Blumenbach, De Sinibus Frontal.

+ The termination of the supra-trochlear is probably sheathing the frontal nerve.

b. Palpebral filaments.—These are given off at the margin of the orbit, and supply the component structures of the upper lid.

196. *Lachrymal nerve.*—This is the smallest of the three divisions of the ophthalmic. It proceeds along the outer side of the orbit, either through, or beneath, the lachrymal gland, and is finally distributed to the upper eyelid. Its branches within the orbit are —1, several filaments to the *lachrymal gland*; 2, a *malar* nerve, which traverses a minute canal in the malar bone, and supplies the skin of the cheek; 3, one or two nerves, which pass down to communicate with the superior maxillary division of the fifth; 4, a *temporal* nerve, which traverses the outer wall of the orbit, and joins one of the temporal branches of the inferior maxillary nerve.* This is often absent.

197. The *fourth*, or *nervus patheticus.*—This nerve enters the orbit above the other nerves which pass through the sphenoidal fissure. It proceeds forwards and inwards over the origin of the levator palpebræ, and, after a short course, enters the orbital surface of the superior oblique muscle, to which it is exclusively distributed.

198. *Lachrymal gland.*—This is situated within the slight excavation of the external angular process of the frontal bone. It is about the size and shape of an almond. Its upper surface is convex, in adaptation to the roof of the orbit; its lower is concave, in adaptation to the eyeball. The anterior part of the gland, sometimes partially detached from the rest, and by some anatomists described as a separate lobe, lies close to the outer and back part of the upper eyelid, and is covered by the conjunctiva. The whole gland is maintained in its proper situation by a capsule† formed by the fascia of the orbit. The structure of this gland resembles that of the salivary. It consists of an aggregation of small lobes, themselves composed of smaller lobules, connected by cellular tissue. The excretory ducts, from eight to twelve in number, proceed from the anterior part of the gland, run parallel, and, after a

* Meckel: De Quinto pare Nervor Cerebri.

† This capsule, being a little stronger on the under surface of the gland, is described and figured by Sœmmerring as a distinct ligament: Icones Oculi Humani, tab. vii.

short course, perforate the conjunctiva about a quarter of an inch above the edge of the tarsal cartilage. These ducts are not easily discovered in the human eye, but in that of the horse or bullock they are of sufficient size to admit a small probe. The secretion of the lachrymal gland keeps the surface of the cornea constantly moist and polished. But if dust, or any foreign substance, irritate the eye, the tears flow in abundance, and wash it off.

We may now examine the muscles of the orbit. All of these, with the exception of the inferior oblique, arise from the back of the orbit near the foramen opticum, and pass forwards, like ribands, to their insertions.

199. *Levator palpebræ superioris.*—This muscle arises from the roof of the orbit, immediately in front of the optic foramen. It proceeds forwards, gradually increasing in breadth, and terminates in a broad and thin aponeurosis, which is chiefly inserted into the upper edge of the tarsal cartilage beneath the palpebral ligament; but a few tendinous fibres pass down to the ciliary edge of the tarsus. *Action.*—It draws the upper lid beneath the edge of the orbit. It is constantly in action when the eyes are open, in order to counteract the tendency of the lids to fall. As sleep approaches, the muscle relaxes, the eyes, in common language, feel heavy, and the lids close.

200. *Obliquus superior.*—This muscle arises from the inner side of the foramen opticum. It proceeds along the inner side of the orbit, and terminates in a round tendon, which passes through a cartilaginous pulley attached to the inner part of the roof of the orbit, near the margin. From this pulley the tendon is reflected at an acute angle outwards and backwards between the rectus superior and the globe of the eye. It gradually expands, and is inserted into the sclerotica, rather behind the middle of the globe, between the external and superior recti muscles. The pulley is lined by a synovial membrane which is continued for a short distance upon the tendon. The *action* of this muscle will be considered with that of the inferior oblique.

The frontal nerve, and elevator muscle of the lid, should now be divided and turned aside in order to expose the superior rectus muscle.

201. *Recti muscles.*—These are four flat muscles, which have a tendinous origin round the foramen opticum, so that collectively they embrace the optic nerve at its entrance into the orbit. They pass forwards, slightly diverging from each other, one above, another below, and one on either side of the optic nerve; and they are named, accordingly, rectus superior, inferior, externus, and internus. They terminate in four broad and shining tendons, which are firmly inserted into the four opposite sides of the sclerotica, about a quarter of an inch, on the average, from the margin of the cornea.

a. The *external* rectus not only arises, in common with the others, from the circumference of the optic foramen, but has also another origin from the inner margin of the sphenoid fissure. Between these origins there pass the third nerve, the nasal branch of the fifth, the sixth, and commonly the ophthalmic vein, into the orbit.

By means of the recti muscles we are enabled to direct the axis of the eye towards different points: hence the names given to them by Albinus—attollens, depressor, adductor, and abductor oculi. It is obvious that by the single action of one, or the combined action of two of these muscles, the eye can be turned towards any direction, within certain limits. If a greater extent of motion is required, we direct the axis of vision to the object by turning the whole head.

202. It is necessary to follow the recti muscles to the globe of the eye, in order to see the delicate shining tendons by which they are inserted into the sclerotic coat. We have already mentioned that they are severally invested by a membrane, or fascia, which passes from one to the other, forming a sort of loose tunic over the back of the eye. This is sometimes called the "fascia bulbi." It is this fascia which resists the passage of the hook in the operation for the cure of squinting. Even after the complete division of the tendon, the eye may still be held in its faulty position, if this tissue, instead of possessing its proper softness and pliancy, happen to have become contracted and unyielding. Under such circumstances it is necessary to divide it freely with the scissors.

By removing the conjunctival coat of the eye, the tendons of the

recti are soon exposed. The breadth and the precise situation of their insertion deserves attention in reference to the operation for strabismus.

203. The breadth of their insertion is about three-eighths of an inch, but the line of this insertion is not at all points equidistant from the cornea. The centre of the insertion is nearer to the cornea by about one line than either end. Taking the internal rectus, which, by the way, we have most frequently occasion to divide in strabismus, we find that the centre of its tendon is, upon an average, three lines only from the cornea, the lower part nearly five lines, and the upper four. It is, therefore, very possible that the lower part may be left undivided in the operation, being more in the background than the rest. The tendon of the internal rectus is nearer to the cornea than either of the others.

a. The superior rectus must now be divided and turned aside; in doing so, observe the branch of the third nerve, which supplies this and the levator palpebræ. After the removal of a certain quantity of fat and cellular tissue, we expose the following parts:—1. The optic nerve. 2. The nasal nerve, and the ophthalmic artery and vein, all of which cross over the optic nerve from without inwards. 3. A little deeper towards the back of the orbit, between the optic nerve and the external rectus, is situated a small reddish body, about the size of a flattened pin's head, called the lenticular ganglion. By tracing the third and the sixth nerve backwards, it may be seen that they enter the orbit between the two origins of the external rectus muscle. These must be severally examined.

204. *Nasal nerve.*—This is one of the three divisions of the ophthalmic branch of the fifth pair. It enters the orbit through the sphenoidal fissure between the two origins of the external rectus, and then crosses over the optic nerve towards the inner wall of the orbit. Here, after giving off the *infra-trochlear* branch, the nerve passes out of the orbit through the foramen orbitale internum anterius, traverses a short bony canal which conducts it into the cranium,* where it lies beneath the dura mater, upon the cribriform

* We have seen instances in which the nasal nerve entered at once into the cavity of the nose without passing through the cranium.

plate of the æthmoid bone. However, it soon leaves the cranium by passing through a slit near the "crista galli," and enters the nose. Here it gives off slender filaments to the mucous membrane of the upper part of the septum narium, and the upper spongy bone; but the main continuation of the nerve descends along a groove behind the nasal bone, becomes superficial between the bone and the cartilage, and, under the name of naso-lobular (see § 52), is finally distributed to the integuments of the ala of the nose.

The following branches given off by the nasal nerve in the orbit are described in the order in which they arise:—

a. One, or perhaps two, slender filaments to the *lenticular ganglion.*

b. Two *long ciliary* nerves. They proceed along the optic nerve to the back of the globe of the eye, pass through the sclerotic coat, and supply the iris.

c. Infra-trochlear nerve.—This runs along the inner wall of the orbit, leaves this cavity below the pulley of the superior oblique, and divides into filaments, some of which supply the skin at the inner angle of the eye, and the root of the nose; others are distributed to the eyelid and lachrymal sac.

205. *Optic nerve.*—Having passed through the optic foramen, this nerve proceeds forwards and a little outwards to the globe of the eye, which it enters on the nasal side of its axis. It is cylindrical in form, and is invested by a dense fibrous coat derived from the dura mater. At the optic foramen it is surrounded by the tendinous origins of the recti; in the rest of its course, by loose fat and cellular tissue, and by the ciliary nerves and arteries.

206. *Ophthalmic artery.*—This artery arises from the internal carotid, close to the anterior clinoid process of the sphenoid bone. It enters the orbit most frequently through the optic foramen, below and outside the optic nerve; occasionally, however, through the sphenoidal fissure. Its course is remarkably tortuous. It is situated at first on the outer side of the optic nerve, then crosses over it, and, running along the inner side of the orbit to the inner angle of the eye, finally inosculates with the internal angular artery (a branch of the facial). Its numerous branches commonly arise in the following order:—

a. Lachrymal artery.—This proceeds along the outer side of the orbit to the lachrymal gland. After supplying the gland, it runs forwards, and terminates in the upper eyelid.

b. Supra-orbital artery.—This is a branch of considerable size. It runs forwards with the frontal nerve along the roof of the orbit, and emerges on the forehead through the supra-orbital notch (see § 179).

c. Arteria centralis retinæ.—This is a small branch which enters the optic nerve near the back of the orbit, and runs in the centre of this nerve to the interior of the eye.

d. Ciliary arteries.—These proceed very tortuously forwards with the optic nerve. They vary from fifteen to twenty in number, and perforate the sclerotic coat at the back of the eye, in order to supply the choroid coat and the iris. They are sometimes called "*posterior ciliary,*" in order to distinguish them from other arteries named "*anterior ciliary,*" which proceed with the tendons of the recti muscles, and enter the front part of the sclerotica. In inflammation of the iris the vascular zone round the cornea arises from enlargement and congestion of these anterior ciliary arieries.

e. Œthmoidal arteries.—These pass through the foramina on the inner wall of the orbit, into the nose, and supply the mucous membrane.

f. Muscular arteries.—These are uncertain in their origin, and are given off chiefly by the branches already described.

g. Palpebral arteries.—Two or more for each lid proceed from the lachrymal, nasal, and supra-orbital branches.

h. Nasal artery.—This may be considered as the termination of the ophthalmic. It leaves the orbit on the nasal side of the eye, and inosculates with the angular artery. It supplies the side of the nose and the lachrymal sac.

207. *Ophthalmic vein.*—This commences at the inner angle of the eye, by a communication with the angular and frontal veins. It runs backwards in a more straight course than the artery, receiving corresponding branches, and finally passing between the two origins of the external rectus terminates in the cavernous sinus.

208. *Ophthalmic* or *lenticular ganglion.*—This little body is situated at the back of the orbit, between the optic nerve and the ex-

ternal rectus muscle, close to the ophthalmic artery. It receives a branch *(sensitive root)* from the nasal nerve, another *(motor root)* from the lower division of the third nerve, and it also receives *(sympathetic)* filaments from the plexus round the internal carotid artery. The ganglion thus furnished with motor, sensitive, and sympathetic roots, gives off the ciliary nerves. These, from ten to twelve in number, run forward very tortuously with the optic nerve, pass through the back of the sclerotica, and are distributed to the iris. Since the ciliary nerves derive their motor influence from the third nerve, we see at once that the iris must lose its power of motion when this nerve is paralysed.

The optic nerve and ophthalmic artery should now be divided near the back of the orbit. With a little dissection we shall find the inferior rectus muscle, the lower division of the third nerve, and the sixth nerve.

209. *Third nerve*, or *motor oculi.*—Just before it enters the sphenoidal fissure, the third nerve divides into two branches, both of which commonly pass between the origins of the external rectus. The upper division has been already traced into the superior rectus and levator palpebræ (see § 203, *a*). The lower division supplies a branch to the internal rectus, another to the inferior rectus, and then runs along the floor of the orbit to the inferior oblique muscle.

210. *Sixth nerve*, or *motor externus.*—This nerve enters the orbit between the origins of the external rectus, and terminates in numerous fine filaments, which are exclusively distributed to this muscle.

Respecting the motor nerves in the orbit, it may be observed that they all enter the ocular surface of the muscles, with the single exception of the fourth. This arrangement is just what might have been expected from the position which the muscles and nerves respectively hold to each other at the back of the orbit.

211. *Inferior oblique muscle.*—To see this muscle an incision must be made along the lower border of the orbit. It arises by a flat tendon from the superior maxillary bone, within the margin of the orbit, near the lower part of the lacrymal groove. It passes obliquely outwards and backwards between the rectus inferior and

the orbit, then curving upwards between the globe and the external rectus, is inserted by a broad thin tendon into the outer and back part of the sclerotic coat of the eye, close to the tendon of the superior oblique, but rather nearer to the optic nerve.

212. *Action of the oblique muscles of the eye.*—The use of the oblique muscles is to move or rotate the eye upon its antero-posterior axis, so that, however much the head be moved obliquely to one side or the other, the image of the object may be always kept stationary upon one and the same point of the retina. This was first explained by Hunter. He says,—"When the head is moved towards the right shoulder, the superior oblique muscle of the right side acts and keeps the right eye fixed on the object, and a similar effect is produced upon the left eye by the action of its inferior oblique muscle. When the head moves in a contrary direction, the other oblique muscles produce the same effect.*

213. *Orbital branch of the superior maxillary nerve.*—This is at all times of small size, and sometimes absent. It comes from the trunk of the superior maxillary in the spheno-maxillary fossa, enters the orbit through the corresponding fissure, and divides into two branches. Of these, one communicates with the lachrymal branch of the ophthalmic, supplies very delicate filaments to the lachrymal gland, and finally terminates in the skin of the upper eyelid; the other, sometimes called the "*temporo-malar*,"† usually divides into two branches, both of which pass through foramina in the malar bone, one to join the temporal branches of the inferior maxillary nerve, the other to supply the skin of the cheek.

214. SUPERIOR MAXILLARY NERVE AND SPHENO-PALATINE GANGLION.—In order to trace this nerve and its branches, we must remove with the saw or the bone forceps the outer wall of the orbit, and nearly all the greater wing of the sphenoid bone, so as to make a free exposure of the spheno-maxillary fossa. This requires to be done with care, else the nerve is sure to be injured.

* Observations on Certain Parts of the Animal Economy.

† "*Subcutaneus malæ*" of Soemmerring and Meckel.

The same dissection exposes the terminal branches of the internal maxillary artery.

215. The *superior maxillary nerve* is the second division of the fifth cerebral nerve. Proceeding from the Gasserian ganglion (see § 188), it leaves the skull through the foramen rotundum, passes horizontally forwards and a little outwards across the spheno-maxillary fossa, enters the infra-orbital canal with the corresponding artery, and finally emerges upon the face through the infra-orbital foramen. The branches should be traced in the order in which they are given off—

a. The *orbital* branch already described (§ 213).

b. Branches to the *spheno-palatine ganglion.*—In the spheno-maxillary fossa the nerve sends down two branches to a small ganglion situated immediately below it. This ganglion will be described presently.

c. One or two small *palatine* nerves.—These descend, independent of the spheno-palatine ganglion, to the palate.

d. Posterior dental branches.—Of these there are commonly two or three. They descend along the back part of the superior maxillary bone, and divide into smaller branches which pass through holes in the bone in company with minute arteries, and then run up the fangs of the molar teeth to supply the pulp. They also supply the gums, and the lining membrane of the antrum.

e. Anterior dental branch.—This arises just before the nerve emerges from the infra-orbital foramen. It descends in a special canal excavated in the anterior wall of the superior maxilla, runs downwards and inwards, and gives off minute filaments to the fangs of the first molar, canine. and incisor teeth. It also supplies the gums and the mucous lining of the antrum. To trace the several branches of this nerve it is necessary to cut away the bone with a chisel.

The terminal branches of the infra-orbital nerve were dissected with the face (§ 74).

At this stage of the dissection it is necessary to make a vertical incision rather on one side of the middle line of the skull, in order to expose the cavity of the nose. We shall thus be able to

dissect with greater facility the spheno-palatine ganglion and its branches.

216. SPHENO-PALATINE GANGLION.—This little body, commonly called, after its discoverer, "*Meckel's ganglion,*" is situated in the spheno-maxillary fossa, close to the outer side of the spheno-palatine foramen, and immediately below the superior maxillary nerve. It is oval in form, with the long axis about one line in length; but in this respect there is considerable variety. Its *sensitive* roots proceed from the superior maxillary; its *motor* from the vidian branch of the facial; and its *sympathetic* from the carotid plexus. Thus supplied, it furnishes branches to the mucous membrane and glands of the hard and soft palate, and to the back part of the nose. These several branches proceeding to and from the ganglion may be traced according to the convenience of the dissector. But it is necessary to have a bone forceps and a chisel, because many of them run in bony canals.

a. Branches connecting the ganglion to the superior maxillary nerve.—There are commonly two; one appears to proceed from the nerve to the ganglion, the other from the ganglion to the nerve.

b. Branches to the palate.—In order to see these the mucous membrane must be removed from the back part of the nose; we shall then be able to trace and dissect out the palatine nerves through the transparent walls of the bony canals in which they descend. Their course is indicated by corresponding arteries. There are generally three of these nerves, called by names originally given to them by Meckel, *anterior, middle,* and *posterior* palatine. The *anterior,* often described as the large palatine nerve, descends through the large palatine canal to the roof of the mouth, and then runs forwards along the hard palate nearly to the gums of the incisor teeth; but one or two branches proceed backwards to supply the soft palate. Before it emerges from its canal, it gives off a filament which passes through the perpendicular plate of the palate bone to the mucous membrane of the nose. The *middle* palatine descends either in the same canal with the preceding, or in

a smaller one of its own, and terminates exclusively in the mucous membrane and glands of the soft palate. The *posterior* palatine nerve may be traced in a special bony canal down to the soft palate, where it terminates in the mucous membrane and glands. One or two filaments pass into the uvula.*

c. Spheno-palatine or *nasal branches.*—These, three or four in number, pass through the spheno-palatine foramen to the mucous membrane of the nose; but they are so delicate that they nearly escape observation. To see them clearly, the part should have been steeped for some time in dilute nitric acid: afterwards, having been well washed in pure water, the delicate filaments of these minute nerves may be easily recognised beneath the mucous membrane covering the spongy bones. Most of them ramify upon the outer wall of the nose and the spongy bones. One branch, originally called by Scarpa† "*naso-palatine,*" traverses the roof of the nose, distributes filaments to the back part of the septum narium, and then proceeds obliquely forwards along the septum to the foramen incisivum, through which it passes, and finally terminates in the palate behind the incisor teeth.‡

d. Branches to the pharynx and Eustachian tube.—In parts prepared for the purpose we may sometimes trace minute filaments to the mucous membrane of the back of the nares, the Eustachian tube, and sphenoidal sinus.

* According to Longet, Anat. et Physiol. du Système Nerveux, Paris, 1842, the posterior palatine nerve supplies the levator palati and the azygos uvulæ with motor power. In this view of the subject, the nerve is considered to be the continuation or terminal branch of the motor root of the ganglion, that, namely, derived from the facial. This opinion is supported by cases in which the uvula is stated to have been drawn on one side in consequence of paralysis of the opposite facial nerve. However, we have not succeeded in tracing the nerve into these muscles.

† Annot. Anat. lib. ii. tab. 1.

‡ According to Cloquet, the corresponding nerves of opposite sides unite at the foramen incisivum in a small ganglion which he calls the "naso-palatine." Dissert. sur les Odeurs et les Organes de l'Olfaction. Paris, 1815.

e. Vidian branch.—This is a very difficult nerve to trace. It proceeds from the posterior part of the ganglion, runs horizontally backwards through the canal at the root of the pterygoid process of the sphenoid bone, traverses the fibro-cartilage at the base of the skull, and here divides into two branches. One joins the sympathetic plexus about the internal carotid artery; the other (sometimes called the *large petrosal*) enters the cranium, runs outwards and backwards under the Gasserian ganglion and the dura mater, in a small groove on the petrous portion of the temporal bone, and finally enters the "hiatus Fallopii," and joins the facial nerve. It is probable that the vidian nerve proceeds not from, but to the ganglion, and that it is the medium through which motor filaments are conveyed to it.*

217. Otic ganglion.—In order to dissect this ganglion it is desirable that the parts concerned be taken from the basis of the skull of a fresh subject.

The otic or auricular ganglion was discovered and described by Arnold, a celebrated German anatomist, in 1826.† "It is situated," he says, "in man on the inner side of the inferior maxillary division of the fifth pair, immediately below its exit through the foramen ovale, and above the origin of the tempo-auricular nerve. Its inner surface is in contact with the circumflexus palati muscle and the cartilage of the Eustachian tube, and immediately behind it is the middle meningeal artery." It is always of very small size; and since we have sometimes failed in finding it, we conclude it is not present in all subjects.

Respecting its connexions with other nerves, Arnold states that it derives filaments (of sensation) from the inferior maxillary, and also from the branch of this nerve which goes to the internal pterygoid muscle. It also derives a slender filament from the temporo-auricular nerve. Its communication with the sympathetic is established by filaments which proceed from the "nervi molles" accompanying the internal maxillary artery. It communicates

* See Longet, Anat. et. Phys. du Système Nerveux, vol. ii. p. 414.

† J. Arnold, Diss. inaug. med. &c. Heidelbergae, 1826.

also with the facial and glosso-pharyngeal nerves by a branch commonly called the *small petrosal* nerve. This nerve passes backwards either through the foramen ovale or the foramen spinosum, or else through a small hole between the two, and then runs beneath the dura mater along a minute groove on the petrous bone (outside the large petrosal nerve). Here it divides into two filaments, one of which joins the facial nerve in the aqueductus Fallopii, the other joins the tympanic branch of the glosso-pharyngeal. These nerves are exceedingly difficult to trace, not only on account of their minute size, but also because they frequently run in canals in the petrous portion of the temporal bone.

The otic ganglion appears to send a branch to the tensor tympani and to the circumflexus palati muscles.

It may fairly be asked why Arnold called the ganglion "otic or auricular." He states that by means of a filament from the lesser petrosal it communicates with the auditory nerve. But this must be doubtful, to say the least, since no other anatomist has, so far as we know, traced any connexion of the kind.

DISSECTION OF THE EIGHTH PAIR OF NERVES AT THE BASE OF THE SKULL.

218. In this dissection we propose to examine the glosso-pharyngeal, pneumo-gastric, and spinal accessory nerves in the jugular fossa, and also the little ganglia and nerves belonging to them in this part of their course. These are very minute points of anatomy, and can hardly be followed out with success unless the nerves have been previously hardened by spirit, and the bones softened by acid. The first thing to be done is to remove the outer wall of the jugular fossa.

219. *Glosso-pharyngeal.*—This passes through a separate tube of dura mater in front of that for the other two nerves. Looking at it from the interior of the skull we observe that it is situated immediately in front and rather to the inner side of the great jugular sinus.

In its passage through the fossa, the nerve presents two

ganglionic enlargements, named respectively the *jugular* and the *petrous*.

220. The *jugular ganglion* (ganglion superius), has been particularly described by Müller.* It is seen upon the nerve immediately after its entrance into the canal of the dura mater, and is so small that its size does not in any direction exceed $\frac{1}{24}$ of an inch. It occupies the outer side of the nerve, and does not implicate all its fibres. According to our observation, however, this ganglion is very frequently absent.

221. The *petrous ganglion* (commonly called, after its discoverer, the ganglion of Andersch †) is situated upon the glosso-pharyngeal nerve, near the lower part of the jugular fossa. It is oval in form, and about $\frac{1}{6}$ of an inch long. It is connected by filaments to the pneumogastric and sympathetic nerves, and it gives off what is called the *tympanic* nerve.‡ This *tympanic* branch of the glosso-pharyngeal ascends through a minute canal in the bony ridge which separates the carotid from the jugular fossa, to the inner wall of the tympanum, and terminates in several filaments. One traverses a bony canal to the plexus of sympathetic nerves round the carotid artery; a second goes to the fenestra ovalis; a third to the fenestra rotunda; a fourth is distributed to the mucous membrane of the Eustachian tube; a fifth ascends in front of the fenestra ovalis, traverses the upper wall of the tympanum, and joins the large petrosal nerve in the hiatus Fallopii (see § 216, *e*); a six takes nearly a similar course, and under the name of the small petrosal nerve proceeds along the front surface of the petrous bone to the otic ganglion (see § 217). Thus it would appear that this tympanic branch is distributed to the mucous membrane of the tympanum and the Eustachian tube, and that it communicates with the spheno-palatine ganglion through the greater petrosal nerve, and with the otic ganglion through the lesser petrosal.

It is fair to state that we have rarely succeeded in tracing each of the preceding filaments, and never all in the same subject.

* Medicin. Zeitung, Berlin, 1833, No. 52.

† Andersch, Fragm. descript. nerv. cardiac, 1791.

‡ This nerve, though commonly called Jacobson's, was fully described by Andersch.

222. *Pneumo-gastric nerve.*—This nerve leaves the cranium in company with the nervus accessorius, through a canal in the dura mater behind that for the glosso-pharyngeal. At its entrance into the canal it is composed of a number of separate filaments; but the filaments very soon become closely aggregated and imbedded in a small ganglion. This ganglion, first described by Arnold,* is rather round in form, and about $\frac{1}{12}$ of an inch in diameter. It is connected by filaments to the sympathetic and to the petrous ganglion of the glosso-pharyngeal. But its most singular branch is one named by Arnold "the *auricular*," because it is distributed to the pinna of the ear. This branch enters a minute foramen in the jugular fossa, near the styloid process, and then proceeds through the substance of the bone to the aqueductus Fallopii, where it divides into two branches; one joins the facial nerve, the other passes to the outside of the head through a canal between the front of the mastoid processs and the meatus auditorius, and is distributed to the back of the cartilage of the ear.

Immediately below this its first ganglion the pneumo-gastric nerve is joined by two branches from the nervus accessorius, and consequently becomes after this junction a compound nerve.† The great ganglion of this nerve at the base of the skull has been already examined (§ 91, A.)

DISSECTION OF THE FACIAL NERVE THROUGH THE TEMPORAL BONE.

223. It is more convenient to trace this nerve in a retrograde direction, beginning at the stylo-mastoid foramen. A transverse section should be made through the temporal bone between the external meatus and the mastoid process. The nerve may then be followed through the interior wall of the tympanum till it makes a sudden bend inwards to the meatus auditorius internus.

* Der Kopftheil, des veget. Nerven Systems. Heidelberg, 1831.

† Physiologists have not yet agreed as to the precise nature of the pneumo-gastric nerve at its origin.

224. The *portio dura* or *facial nerve,* having arrived at the bottom of the meatus auditorius internus, enters what is called the "*canalis* or *aqueductus Fallopii*."* This is a tortuous canal excavated through the substance of the temporal bone, and terminating at the stylo-mastoid foramen. In this canal the nerve runs. When exposed throughout its whole course, we observe that the nerve proceeds from the meatus internus for a short distance outwardly, then makes a sudden bend backwards along the inner wall of the tympanum above the fenestra ovalis, and lastly, curving downwards at the back of the tympanum, it leaves the skull at the stylo-mastoid foramen. The most important part of its course is the bend or knee, as it is called. In this situation it is considerably swollen, and gives off—

a. The *large petrosal* nerve (vidian) which runs to the spheno-palatine ganglion (see § 216, *e*).

b. The *small petrosal* nerve, which runs to the otic ganglion (see § 217).

c. Chorda tympani.—This nerve takes a very remarkable course. It arises at an acute angle from the facial about $\frac{1}{4}$ of an inch before its exit from the stylo-mastoid foramen, ascends for a short distance in a bony canal at the back of the tympanum, and enters that cavity below the pyramid and close to the membrana tympani. It then runs forwards through the tympanum, across the handle of the malleus, to the fissura Glaseri, through which it emerges at the base of the skull, and joining the gustatory nerve finally proceeds to the submaxillary ganglion (see § 28, *a.*)

DISSECTION OF THE NOSE.

225. Presuming that the learner is familiar with the bones composing the skeleton of the nose, we shall now describe—1. The nasal cartilages; 2. The general figure and arrangement of the nasal cavities; 3. The membrane which lines them; and lastly,

* Fallopius was a distinguished Italian anatomist, and professor at Pavia, 1551.

all that is known respecting the distribution of the olfactory nerves.

The skin of the nose is abundantly supplied with sebaceous glands; of which the ducts become very apparent when the cuticle is removed.

226. *Cartilages of the nose.*—Two pieces of fibro-cartilage on either side assist in forming the framework of the external nose; and one in the centre completes the septum between the nasal fossæ.

227. The *cartilage of the septum* is commonly placed perpendicularly in the middle line; it may lean a little, however, to one side or the other, and in some rare instances it is perforated, so that the two nasal cavities communicate with each other. Its outline is nearly triangular. The posterior border is received into a groove in the perpendicular plate of the æthmoid bone and the vomer; the anterior border, that namely beneath the skin, is much thicker than the rest of the septum, and is connected, superiorly, with the nasal bones, and on either side with the lateral cartilages.

228. Of the *lateral cartilages* there are two, an upper and a lower. The *upper* is connected, superiorly, to the margin of the nasal and maxillary bones, anteriorly to the cartilage of the septum, and inferiorly to the lower cartilage by means of a tough fibrous membrane. The *lower* is sometimes called the cartilage of the pinna. It is curved upon itself in such a way as to form the boundary of the external opening of the nose. Superiorly, it is connected by fibrous membrane to the upper lateral cartilage; internally it is in contact with its fellow of the opposite side, forming the upper part of the "columna nasi;" posteriorly it is attached by fibrous tissue to the superior maxillary bone: in this tissue, at the base of the ala, are usually found two or three nodules of cartilage, called *"cartilagines sesamoideæ."* We cannot but admire how well these cartilages are adapted to their office. By their elasticity they keep the nostrils continually open, and restore them to their ordinary size whenever they have been expanded by muscular action.

The little muscles moving the nasal cartilages have been described with the dissection of the face (see § 68).

229. *Interior of the nose.*—By making a vertical section

through the nasal cavities, a little on one side of the middle line, we expose the partly bony and partly cartilaginous partition (*septum narium*) by which they are divided. We notice that the greatest perpendicular depth of each nasal fossa is about the centre, and that from this point the depth gradually lessens, both towards the anterior and the posterior openings of the nose. Laterally, each fossa is very narrow in consequence of the projection of the spongy bones towards the septum: this narrowness in the transverse direction explains the rapidity with which swelling of the lining membrane from a simple cold may obstruct the passage of the air.

The boundary of the nasal fossæ is formed by the following bones: Superiorly, there are the strong nasal bones, the æthmoid, and the body of the sphenoid; inferiorly, there are the horizontal plates of the maxillary and palate bones; internally, there is the smooth and flat septum formed by the æthmoid, the vomer, and the cartilage; externally, there are the maxillary, the lachrymal, the æthmoid, the palate, and the pterygoid plate of the sphenoid bone.

230. *Meatus.*—The outer wall of the nasal cavity is divided by the turbinated bones into three compartments (meatus) of unequal size; and in these there are orifices leading to air-cells (sinus) in the sphenoid, æthmoid, frontal, and superior maxillary bones. Each of these compartments we should individually examine.

231. The *superior meatus* is the smallest of the three, and does not extend beyond the posterior half of the wall of the nose. We find in it one wide opening, or perhaps two of smaller size, which lead into the posterior æthmoidal cells, and another which leads into the sphenoidal.

232. The *middle meatus* is larger than the superior. At its anterior part is observed a long narrow passage (infundibulum), which conducts upwards and forwards to the frontal and the anterior æthmoidal cells. About the middle there is a small opening which leads into the great air cavity, or antrum of the superior maxilla: this opening in the dry bone is large and irregular, but in the recent state it is considerably reduced in size by mucous membrane, so that a very little swelling of the membrane is sufficient to close the orifice entirely.

It may be noticed that the orifices of the frontal and æthmoid

cells are so disposed that the secretion from their interior will, by its own gravity, pass into the nose. But this is not the case with the sphenoid and the maxillary cells; to empty which it is necessary that the head be inclined on one side. To see all these openings, we must, of course, raise the respective turbinated bones.

233. The *inferior meatus* extends nearly along the whole length of the outer wall of the nose. By raising the lower turbinated bone, we observe, towards the front of the meatus, the termination of the nasal duct, through which the tears pass down from the lachrymal sac into the nose. This sac and duct we may now conveniently examine.

234. *Lachrymal sac and duct.*—These, together, constitute the passage through which the tears are conveyed from the lachrymal canals into the nose (see § 62, *d).* The lachrymal sac occupies the excavation on the nasal side of the orbit, formed by the lachrymal and superior maxillary bones. The upper end is round and closed; the lower gradually contracts into the nasal duct, a tube about half an inch long. A slight constriction marks the point where the sac terminates and the duct begins. When the duct is obstructed, either from thickening of its lining membrane or from various diseases in the surrounding parts, the sac becomes distended by the tears, and forms a conspicuous tumor at the inner angle of the eye. The sac is composed of a strong fibrous membrane which adheres very closely to the bone, and is lined by mucous membrane. Its front surface is covered by the tendo oculi and the fascia proceeding from it (see § 58).

The direction of the nasal duct is downwards and backwards. Its termination is generally guarded by a valvular-like fold of mucous membrane; consequently, when air is blown into the nasal passages while the nostrils are closed, the lachrymal sac does not, in most persons at least, become distended.

Behind the inferior turbinated bone is seen the opening of the Eustachian tube (see § 157). Into this, as well as into the nasal duct, we ought to practise the introduction of a probe. The chief difficulty, in our first attempts, is to prevent the probe from slipping into the cul-de-sac between the tube and the back of the pharnyx.

235. *Mucous* or *Schneiderian* membrane.*—This membrane lines the cavities of the nose and the air-cells about it, and adheres very firmly to the periosteum. We observe that at the lower border of the several turbinated bones it is disposed in more or less thick and loose folds. Such a fold is in some instances so prominent on the lower turbinated bone that, if slightly swollen, it might very likely be mistaken during life for a polypus. The membrane varies in its degree of thickness and vascularity in different parts of the nasal cavities. Upon the lower half of the septum and the lower turbinated bones it presents a much greater thickness than elsewhere, in consequence of a minute plexus of tortuous arteries and veins in the submucous tissue. The veins are especially numerous. Their sudden turgescence produces the temporary obstruction, in one or other of the nasal passages, so common in an ordinary cold. In the sinuses, on the other hand, the mucous membrane is thinner and less vascular, and so closely applied upon the periosteum that it is usually described as a fibro-mucous membrane.

The greater vascularity of the Schneiderian membrane in that particular part of the nose which is used as a respiratory passage, is obviously intended to elevate the temperature of the inspired air, and to pour out a copious secretion which answers the double purpose of partially saturating the air with vapour, and of preventing the membrane itself from becoming too dry. Every one is aware that breathing is performed more comfortably through the nose than through the mouth.

In the neighbourhood of the nostrils the mucous membrane is furnished with papillæ and a scaly epithelium, like the skin. In the sinuses and all the lower regions of the nose the epithelium is columnar, and provided with cilia; but in the upper part of the nose, where the sense of smell resides, we no longer find ciliated epithelium, but a soft pulpy stratum of nucleated cells.†

236. *Blood-vessels of the interior of the nose.*—The arteries of

* So named in honour of Schneider, a learned anatomist who first gave an accurate description of this membrane. De Catarrhis. Wittenberg, 1660.

† See Bowman and Todd, Physiolog. Anatom., cap. xvi.

the nose are, the æthmoidal and nasal branches of the ophthalmic, the nasal branch of the internal maxillary, and others derived from variable sources. The external nose is supplied y the arteria lateralis nasi, described § 70, *c*.

The *veins* of the nose correspond to the arteries. They communicate with the veins within the cranium through foramina in the cribriform plate of the æthmoid bone, also through the ophthalmic vein and the cavernous sinus. These communications explain the natural relief afforded by hemorrhage from the nose in cases of cerebral congestion.

237. *Olfactory nerves.*—The olfactory ganglia, being seated within the cranium and forming a part of the brain, will be described with the anatomy of that organ. The olfactory filaments, proceeding from each ganglion, are in number about twenty on either side. They pass through the foramina in the cribriform plate of the æthmoid bone, and in its passage each is invested with a firm fibrous coat derived from the dura mater; so that these filaments, although extremely soft and easily torn within the skull, are, outside it, as firm as any other nerves. In order to make them more conspicuous the bones should be steeped some time in dilute nitric acid. For the convenience of description we divide them into an *inner,* a *middle,* and an *outer* set. The *inner* ones are rather larger and flatter than the rest. They traverse the canals or grooves observable on the upper part of the septum, and, subdividing, terminate in lashes of minute filaments between the periosteum and the mucous membrane. They cannot be traced below the upper half of the septum.

The *middle* ones supply the roof of the nose.

The *outer* ones pass through canals or grooves in the upper and middle turbinated bones, and communicating freely with each other, are lost in the mucous membrane on the convex surfaces of these bones.* None of them can be traced to the inferior turbinated bone, or into any of the air cavities in the adjoining bones.

The precise manner in which the olfactory filaments terminate

* See the beautiful plates of Scarpa and Soemmerring.

upon the mucous membrane is not yet ascertained. The most minute microscopic observations cannot detect any definite arrangement. The ultimate filaments appear to be lost in the mucous tissue.

The olfactory are nerves of special sense only. The common sensibility of the mucous membrane of the nose is supplied by branches from the fifth pair of nerves; namely, the nasal branch of the ophthalmic (see § 204), and the nasal branch of the spheno-palatine ganglion (see § 216, *c*). That the sense of smell is independent of the common sensibility of the nose is proved by experiment and by pathology. For instance, any disease affecting the olfactory nerve, even the inflammation in a common cold, more or less impairs the sense of smell, whereas the common sensation of the part continues equally acute, and becomes even more so, as one may readily ascertain by introducing a foreign body into the nostril.

DISSECTION OF THE MUSCLES OF THE BACK.

238. The muscles of the back which are concerned in the movements of the upper extremity are described in the dissection of the arm (see ARM, § 100). These, therefore, having been removed, we proceed to examine two thin flat muscles, named from their appearance "*serrati*," which extend from the spine to the ribs.

239. *Serratus posticus superior*.—This muscle is situated beneath the rhomboidei (see ARM, § 109). It arises from the ligamentum nuchæ (see ARM, § 102), and the spines of the last cervical, and the two or three upper dorsal vertebræ, by a sheet-like aponeurosis which makes up nearly half the muscle: the fibres run outwards and downwards, and are inserted by fleshy slips into the second, third, fourth, and sometimes the fifth, ribs beyond their angles. Its *action* is to raise these ribs, and therefore more or less to assist in forcible inspiration.

a. Serratus posticus inferior.—This muscle is situated lower down than the preceding, beneath the latissimus dorsi. It takes origin from the strong aponeurosis called "*fascia lumborum*"

(see ARM, § 106), ascends outwards, and is inserted by broad fleshy slips into the four lower ribs external to their angles. The tendency of its *action* is to pull down these ribs, and therefore to assist in expiration.

240. *Vertebral aponeurosis.*—This is a strong shining uninterrupted sheet of fascia which extends from the spines of the vertebræ to the angles of the ribs, and serves to confine the "erector spinæ" muscle in the vertebral groove. We observe that this fascia proceeds from the lower serrate muscle, and that it is continued beneath the upper serrate muscle, so as to bind down the splenius.

241. *Splenius.*—To expose the whole of this muscle, the superior serratus and the vertebral aponeurosis must be turned aside. It arises from the spines of the four or five upper dorsal and the last cervical vertebra, and from more or less of the ligamentum nuchæ. The fibres ascend and divide into two portions, named, according to their respective insertions, *splenius capitis* and *splenius colli.*

a. The *splenius capitis,* the stronger of the two portions, is inserted into the apex and back part of the mastoid process, and into more or less of the surface between the curved ridges of the occipital bones. This insertion is covered by that of the sterno-mastoid.

b. The *splenius colli* is inserted by tendinous slips into the transverse processes of the three upper cervical vertebræ.

The *action* of the splenius, taken as a whole, is to draw the head and the upper cervical vertebræ towards its own side: so far it co-operates with the opposite sterno-mastoid muscle. When the splenii of opposite sides contract, they extend the cervical portion of the spine, and keep the head erect. The permanent contraction of a single splenius may occasion a "wry neck." It is necessary to be aware of this, otherwise one might suppose the opposite sterno-mastoid to be affected, considering that the appearance of the distortion is alike in either case (see § 8).

242. *Erector spinæ.*—The mass of muscle which occupies the vertebral groove on either side of the spine, is, collectively, called "erector spinæ," since it counteracts the perpetual tendency of the head and the trunk to fall forwards. We observe that it is

thickest and strongest at that part of the spine where it has the greatest weight to support, namely in the lumbar region; and that from this point its thickness gradually decreases towards the top of the spine, in proportion to the decrease of the weight. The sheath in which the muscle is contained has already been examined, and we then noticed that the strength of this sheath varies in different parts of the spine, according to that of the muscle. In the lumbar region, for instance, we observed the great strength of the "fascia lumborum" (see ARM, § 106); and in the dorsal, the comparatively feeble "vertebral aponeurosis" (see § 240).

The sheath having been reflected, we observe that in the lumbar and sacral region the erector spinæ is covered by a broad and thick tendon, which is attached to the spines of the lumbar and sacral vertebræ, to the tubercles representing the transverse processes of the sacrum, and to the posterior part of the crest of the ilium.

The muscular fibres take origin from this expanded tendon, from the sacrum between its spinous and transverse processes, and from the whole of that rough surface below the posterior and inner part of the crest of the ilium.

From this extensive origin the muscular fibres ascend, at first aggregated into a single mass. Near the last rib, however, we may observe that this mass divides into two portions, of which the outer is called the *sacro-lumbalis*; the inner, the *longissimus dorsi*. These two portions should be successively followed up the back; and there can be no difficulty in doing so, because the division between them is indicated by a longitudinal groove, in which we observe the several cutaneous branches of the intercostal vessels and nerves.

Tracing, then, the *sacro-lumbalis* upwards, we find that it terminates in a series of tendons which are inserted into the angles of all the ribs.

By turning a little outwards the sacro-lumbalis, we observe that part of it which is called the "*musculus accessorius ad sacro-lumbalem.*" It arises by a series of tendons from the angles of the seven or eight lower ribs: it is at once obvious that the muscular slips proceeding from these tendons form but the dorsal con-

tinuation of the muscle, and that they are implanted into the five or six upper ribs.

243. *Cervicalis ascendens.*—This muscle is only the cervical continuation of the sacro-lumbalis. It arises by tendinous slips from the four or five upper ribs, and is inserted into the transverse processes (or stunted ribs) of the four or five lower cervical vertebræ.

244. Tracing, on the other hand, the *longissimus dorsi* (the inner portion of the erector spinæ), we find that there are detached from it a series of fleshy slips terminating in tendons which are inserted into the tubercles* at the root of the transverse processes of the lumbar vertebræ, also into the transverse processes of all the dorsal vertebræ, and into the greater number of the ribs (varying from eight to eleven) close to their junction with the transverse processes.

245. *Transversalis cervicis.*—This is the cervical continuation of the longissimus dorsi. It arises by tendinous slips from the transverse processes of the third, fourth, fifth, and sixth dorsal vertebræ, and is inserted into the transverse processes of all the cervical vertebræ, excepting the first and the last.

246. *Trachelo-mastoid.*—This muscle, situated on the inner side of the preceding, may be regarded as the continuation of the longissimus dorsi to the back of the cranium. It arises by slips of tendon from the transverse processes of the two or three upper dorsal, and the three or four lower cervical vertebræ, and is inserted by a flat tendon into the back part of the mastoid process beneath the splenius.†

* Called "metapophyses" by Professor Owen.

† Those who are familiar with the modern nomenclature of the vertebrate skeleton, will readily understand, from the following quotation, the plan upon which the muscles of the back are arranged :—

"The muscles of the back are either longitudinal or oblique; that is, they either pass vertically downwards from spinous process to spinous process, from diapophysis to diapophysis, from rib to rib, (pleurapophyses), &c., or they extend obliquely from diapophysis to spine, or from diapophysis to pleurapophysis, &c.

"The erector spinæ is composed of two planes of longitudinal fibres aggre-

247. The *spinalis dorsi* is a long narrow muscle, situated close to the spines of the dorsal vertebræ, and apparently a part of the longissimus dorsi. It arises by thin tendons from the spines of the two lower dorsal and two upper lumbar vertebræ, and is inserted also by little tendons into the spines of the six or eight upper dorsal vertebræ.

The muscles of the spine hitherto examined are all longitudinal in their direction. We have now to notice a series which run obliquely from the transverse to the spinous processes of the vertebræ. And first the complexus.

248. *Complexus.*—In order to obtain a full view of the complexus, the cervical continuation of the erector spinæ must be reflected outwardly. This thick strong muscle arises by a series of tendons from the transverse processes of the four or five upper

gated together, below, to form one mass at their point of origin, from the spines and posterior surface of the sacrum, from the sacro-iliac ligament, and from the posterior third of the iliac crest. It divides into two portions, the sacro-lumbalis and the longissimus dorsi.

"The former, arising from the iliac crest, or from the pleurapophysis (rib) of the first sacral vertebra, is inserted by short flat tendons into (1.) the apices of the stunted lumbar ribs, close to the tendinous origins of the transversalis abdominis; (2.) the angles of the eight or nine inferior dorsal ribs; (3.) it is inserted, through the medium of the musculus accessorius, into the angles of the remaining superior ribs, and into the long and occasionally distinct pleurapophysial element of the seventh cervical vertebra; and (4.) through the medium of the cervicalis ascendens, into the pleurapophysial elements of the third, fourth, fifth, and sixth cervical vertebræ. In other words, the muscular fibres extend from rib to rib, from the sacrum to the third cervical vertebra.

"The longissimus dorsi, situated nearer the spine than the sacro-lumbalis, is inserted (1.) into the metapophysial spine of the lumbar diapophyses; (2.) into the diapophyses of all the dorsal vertebræ, near the origin of the levatores costarum; (3.) through the medium of the transversalis colli into the diapophyses of the second, third, fourth, fifth, and sixth cervical vertebræ; and (4.) through the medium of the trachelo-mastoid into the mastoid process, or the only element of a transverse process possessed by the parietal vertebra. In other words, its fibres extend from diapophysis to diapophysis, from the sacrum, upwards, to the parietal vertebra."—*Homologies of the Human Skeleton*, by H. Coote, p. 75.

dorsal and the last cervical vertebræ, and also from the articular processes of the fourth, fifth, and sixth cervical vertebræ. From this origin it ascends, and is inserted between the two curved lines of the occipital bone, near the vertical crest. In the centre of the muscle there is generally more or less tendinous tissue.* We may observe, also, that the muscle is perforated by the posterior branches of the second (the great occipital), third, and fourth cervical nerves. The *action* of the muscle is to keep the head erect.

Reflect the complexus from the spine, in order to see on its under surface the arteria cervicalis profunda (see § 49), and the posterior branches of the cervical nerves. The tendon of the erector spinæ must be divided longitudinally near the spines of the lumbar vertebræ, and the entire length of the muscle should be reflected outwardly towards the ribs.

249. *M. semi-spinalis.*—This is the next mass of muscle which is exposed in the vertebral groove after the reflection of the complexus and the erector spinæ. It consists of a series of muscles which extend between the transverse and spinous processes of the dorsal and cervical vertebræ, and is usually divided into the *semispinalis colli*, and the *semispinalis dorsi.*

a. The *semispinalis colli* is much stronger than the corresponding muscle in the dorsal region, as one might expect from the greater mobility of the cervical vertebræ. It arises by tendinous slips from the transverse processes of the five or six upper dorsal vertebræ, and is inserted into the spines of the axis and the three or four succeeding vertebræ.

b. The *semispinalis dorsi* arises from the transverse processes of the lower dorsal vertebræ, and is inserted into the spines of the upper dorsal and the two or three lower cervical vertebræ.

250. We must now reflect the semispinalis muscle from the spine, in order to expose what is called the "*multifidus spinæ.*" This, however, may fairly be considered a part of the preceding

* The inner border of the complexus is described by some anatomists as a separate muscle, under the name of "*biventer cervicis,*" simply because there is much tendinous tissue in the centre of it.

muscle, since the fixed points and the direction of its fibres are nearly the same. It consists of a series of little muscles which lie in the groove between the spines and the transverse processes of the vertebræ from the sacrum to the second cervical vertebra. Those in the lumbar region are larger than the others. They arise by tendinous slips from the transverse processes in the sacral and dorsal region, and from the articular processes in the lumbar and cervical region. They all ascend obliquely inwards, and are inserted into the spines and laminæ of all the vertebræ excepting the atlas. It should be observed that their fibres are not of uniform length; some extend only from vertebra to vertebra, while others extend between one, two, or even three vertebræ.

251. Beneath the multifidus spinæ we find in the dorsal region of the spine only, eleven little flat muscles, called by Theile,* who first described them, "*rotatores spinæ.*" They arise from the upper part of the transverse process, and are inserted into the lower border of the lamina of the vertebra above. These muscles form but a part of the multifidus spinæ.

Action.—All these oblique muscles not only assist in maintaining the trunk erect, but they can also bend the spine to one or the other side.

252. *Levatores costarum.*—These little muscles, twelve in number on each side, arise from the apices of the transverse processes of the dorsal vertebræ, descend outwardly, and are inserted into the upper and back part of the rib below. The direction of their fibres corresponds to that of the outer layer of the intercostal muscles.

253. *Interspinales.*—These muscles, as their name implies, extend between the spines of the vertebræ. They only exist in those parts of the vertebral column which are the most moveable, namely the cervical and lumbar regions; but even here they are not always found. In the cervical region they are arranged in pairs. There are none, however, between the two first vertebræ, for obvious reasons. In the lumbar region they are arranged singly.

254. *Intertransversales.*—These muscles extend between the

* Müller's Archives f. Anat. &c. 1839.

transverse processes in the cervical and the lumbar regions of the spine. In the cervical region they are arranged in pairs, like the interspinales, and the corresponding cervical nerve separates one from the other. In the lumbar region they are arranged singly.

We have next to examine a set of muscles concerned in the movement of the first upon the second vertebra, and of the occiput upon the atlas. Of course it is necessary that the complexus be previously reflected.

255. *Rectus capitis posticus major.*—This is but a largely developed interspinal muscle. It arises from the well marked spine of the second vertebra, and, expanding considerably, is inserted below the inferior curved ridge of the occipital bone; in other words, into the spine of the occipital vertebra.

256. *Rectus capitis posticus minor.*—This is also an interspinal muscle, but smaller than the preceding. Arising from the feebly developed spine of the first vertebra, it expands as it ascends, and is inserted into the occipital bone between the inferior curved ridge and the foramen magnum. The *action* of the two preceding muscles is to draw the occiput towards the spine.

257. *Obliquus inferior.*—This arises from the spine of the second vertebra, and is inserted into the transverse process of the first. Its *action* is to rotate the first upon the second vertebra.

258. *Obliquus superior.*—This muscle arises from the transverse process of the first vertebra, ascends inwards, and is inserted behind the mastoid process in the interval between the curved ridges of the occiput. Its *action* is to draw the occiput towards the spine.

It may be observed that the oblique and the recti muscles of one side form the sides of a triangle, in which we discover the branches of the suboccipital nerve and the vertebral artery, in its horizontal course along the arch of the first vertebra.

259. *Rectus capitis lateralis.*—This is a small thin muscle, which extends between the transverse process of the first vertebra, and the *eminentia jugularis,*" so called, of the occiput; but since this eminence is, properly speaking, the transverse process of the occipital vertebra, the muscle must be considered as an intertransverse one.

Having completed the examination of the muscles at the back of the spine, we have next to consider the manner in which they are supplied with nerves and blood-vessels.

260. *Nerves of the back.*—The posterior divisions of the several spinal nerves are intended to supply the muscles and the skin of the back. They pass backwards between the transverse processes of the vertebræ, and then divide (most of them at least) into an external and an internal branch. The general plan upon which these nerves are arranged is nearly the same throughout the whole length of the spine; but since there are certain peculiarities deserving of notice in particular situations, we must examine each region separately.

261. *Cervical region.*—The posterior division of the first cervical nerve (commonly called the suboccipital) passes between the arch of the atlas and the vertebral artery, and divides into branches which supply the recti and obliqui muscles concerned in the movement of the head upon the two first vertebræ.

a. The posterior branch (called the great occipital) of the second cervical nerve is the largest of the series. It turns upwards beneath the inferior oblique muscle, passes through the complexus, and supplies the back of the scalp.

b. The posterior divisions of the remaining six lower cervical nerves divide into *external* and *internal* branches. The *external* are small, and terminate in the splenius, and the continuation of the erector spinæ. The *internal*, by far the larger, proceed towards the spines of the vertebræ; those of the third, fourth, and fifth between the complexus and the semispinalis*; those of the sixth, seventh, and eighth between the semispinalis and the multifidus spinæ: after supplying the muscles proper to this region of the spine, they terminate in the skin (see ARM, § 101).

262. *Dorsal region.*—The posterior divisions of the spinal nerves in this region come out between the transverse processes and the tendons attached to them. They soon divide into *external*

* The posterior branches of the second, third, and fourth nerves are generally connected, beneath the complexus, by branches in the form of loops. This constitutes the posterior cervical plexus of some anatomists.

and *internal* branches. The *external* pass obliquely over the levatores costarum, between the sacro-lumbalis and the longissimus dorsi; and they successively increase in size from above downwards. The six upper ones, more or less, terminate in the erector spinæ and the levatores costarum, but the remaining lower ones, after supplying these muscles, pass through the latissimus dorsi, and become the cutaneous nerves of the back. The *internal* successively decrease in size from above downwards. They run towards the spine between the semispinalis and the multifidus spinæ. The upper six, after giving branches to the muscles, perforate the trapezius and become cutaneous nerves. The lower ones terminate in the muscles of the vertebral groove.

263. *Lumbar region.*—The general arrangement of the nerves in this region resembles that of the dorsal. Their *external* branches supply the multifidus spinæ; their *internal*, after supplying the erector spinæ, become cutaneous.

264. *Sacral region.*—The posterior divisions of the spinal nerves in this region are but small. They come out of the spinal canal through the foramina in the back of the sacrum. The upper two or three divide into *external* and *internal* branches. The *internal* terminate in the muscles; the *external* are generally connected together on the back of the sacrum, and then become cutaneous. The two last sacral nerves proceed, without dividing, to the integument.

265. The *coccygeal* nerves are exceedingly small, and terminate in the skin.*

The general arrangement of the cutaneous nerves of the back is described in the dissection of the Arm (§ 101).

266. *Vessels of the back.*—The vessels which supply the back are:—1. Small branches from the occipital; 2. Small branches from the vertebral; 3. The deep cervical from the subclavian; 4. The posterior branches of the intercostal and lumbar arteries of the aorta.

a. The *occipital* artery (described § 35) furnishes several

* The branching of the posterior divisions of the several spinal nerves has been accurately described by Mr. Ellis, Med. Gazette, Feb. 10th, 1843.

small branches to the muscles at the back of the neck: among others, one (commonly called the princeps cervicis) which, descending beneath the complexus, in some subjects inosculates with the deep cervical artery.

b. The *deep cervical* artery (described § 49) is analogous to the posterior branches of the other intercostal arteries. It ascends between the complexus and the semispinalis muscles.

c. The posterior branches of the intercostal and lumbar arteries accompany the corresponding nerves, and are in all respects similar to them in distribution. They all send a branch into the spinal canal.

The *veins* correspond to the arteries.

We have now to examine three muscles situated in front of the spine; namely, the longus colli, the rectus capitis anticus major, and the rectus capitis anticus minor. But in order to have a complete view of the two latter, a special dissection should be made before the head is removed from the first vertebra.

267. *Longus colli.*—This muscle is situated in front of the spine, and extends from the third dorsal to the first cervical vertebra. For convenience of description it may be divided into two sets of fibres, of which the one extends *longitudinally* from the body of one vertebra to that of another; the other extends *obliquely* between the transverse processes and the bodies of the vertebræ.

a. The *longitudinal* portion of the muscle arises from the bodies of the two or three upper dorsal and the two lower cervical vertebræ, and is inserted into the bodies of the second, third, and fourth cervical vertebræ.

b. The *oblique* portion, arising from the transverse processes of the third, fourth, and fifth cervical vertebræ, ascends inwards, and is inserted into the front part or body of the first cervical vertebra. Other oblique fibres proceed from the bodies of the three upper dorsal vertebræ, and are inserted into the transverse processes of the fifth and sixth cervical vertebræ. The *action* of the muscle, taken as a whole, must obviously be very limited. It tends to bend the cervical region of the spine.

268. *Rectus capitis anticus major.*—This muscle arises from

the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ, ascends nearly perpendicularly, and is inserted into the basilar process of the occipital bone, in front of the foramen magnum.

269. *Rectus capitis anticus minor.*—This muscle arises from the transverse process of the first cervical vertebra, and is inserted into the basilar process of the occipital bone, nearer to the foramen magnum than the preceding muscles. The *action* of the recti muscles is to bend the head forwards.

DISSECTION OF THE LIGAMENTS OF THE SPINE.

270. The several vertebræ are connected by their interarticular fibro-cartilages, by ligaments in front of and behind their bodies, and by ligaments which extend between their arches, their spines, and their transverse processes. There are also capsular ligaments connecting their articular processes.

271. *Anterior common ligament.*—This consists of a strong band of longitudinal fibres which extends over the front of the bodies of the vertebræ from the axis to the sacrum. It should be observed that the fibres are not all of equal length. The more superficial extend from a given vertebra to the fifth or sixth below it; those a little deeper pass from a given vertebra to the second or third below it; while the deepest of all proceed from vertebra to vertebra. The ligament becomes broader and stronger in proportion to the size of the vertebræ. By making transverse incisions through it in different situations, we observe that its fibres are more firmly adherent to the intervertebral cartilages, and to the borders of the vertebræ, than to the middle of the bones.

272. *Inter-spinous ligaments.*—These are thin bands of ligamentous fibres, which fill up the intervals between the spines of the dorsal and lumbar vertebræ. They are the most marked in the lumbar region. Those fibres which connect the apices of the spines, being stronger than the rest, are described by some anatomists as separate ligaments. under the name of *supra-spinous.*

273. *Ligaments between the arches of the vertebræ.*—These are

generally called, on account of their colour, *ligamenta vertebrarum subflava.*—To obtain a good view of them, we ought to remove the arches of the vertebræ with a saw. We may then observe that they extend from the arch of one vertebra to that of the next, filling up the intervals between them. Their strength increases with the size of the vertebræ. But the chief peculiarity about these ligaments is, that they are composed of yellow elastic tissue, so that they lengthen when the spine is bent forwards.

274. *Intertransverse ligaments.*—These are delicate ligamentous bands which extend between the transverse processes of the lumbar and lower dorsal vertebræ. But they serve rather as insertions for muscles, than as ligaments to connect the bones.

275. *Posterior common ligament.*—In order to see this the arches of the vertebræ must be removed. It extends longitudinally after the manner of the anterior common ligament (see § 271), along the posterior surface of the bodies of the vertebræ, from the occiput to the sacrum. But we remark that it gradually decreases in strength and breadth from the upper towards the lower part of the spine.

276. *Intervertebral fibro-cartilage.*—This substance is by far the strongest bond of connexion between the several vertebræ from the axis to the sacrum, and it fulfils most important purposes in the mechanism of the spine. The best way to see the general structure of an intervertebral fibro-cartilage is to make a horizontal section through one of them: say in the lumbar region. We may then observe that its structure is very firm and resisting about the circumference, but soft and pulpy towards the centre. The circumferential portion is composed of a number of circular and concentric fibro-cartilaginous plates, placed vertically or nearly so. These plates are firmly attached by their edges to the vertebræ; they gradually decrease in number from the circumference towards the centre, and the interstices between them are occupied by the soft pulpy tissue. The central portion is composed almost entirely of this pulpy tissue; and the pressure which confines it being removed when a transverse section is made, we see it bulging above the level of the firmer structure.

277. If an intervertebral substance be dissected layer after

layer without making a section of it, we find that the fibro-cartilaginous plates, above alluded to, consist of fibres which extend more or less obliquely between the vertebræ, crossing each other in their direction like the branches of the letter X.

Make a vertical section through an intervertebral substance, in order to see the precise direction of its fibro-cartilaginous plates. Observe that they are not exactly vertical. Those nearest to the circumference are slightly curved forwards, while those more deeply placed curve in the opposite direction. These curves are respectively increased whenever the spine is bent forwards or backwards.

The thickness of the intervertebral cartilages is not the same in front and behind. It is this difference in their thickness, more than that in the fore and back part of the bodies of the vertebræ, which produces the several curves of the spine.* In the lumbar and cervical regions they are thicker in front; in the dorsal region, behind.†

278. *Ligaments connecting the articular processes of the ver-*

* The curve of the spine in the dorsal region must be excepted from this statement: here it depends, in a greater degree, upon the form of the bodies of the vertebræ.

† The structure of the intervertebral cartilages explains the well-known fact, that a man becomes to a certain extent shorter after continuing a long time erect; and that he regains his usual height after resting some time on his back. The difference between the morning and evening stature amounts in some instances to more than half an inch.

It also explains the fact that a permanent unnatural curvature of the spine may be produced (especially in the young) by the habitual practice of leaning forwards, or to this or that side. Experience proves that the cause of spinal curvature depends more frequently upon some alteration in the structure of the fibro-cartilages than upon the bones. From an examination of the bodies of 134 individuals with crooked spines, it was concluded that in two-thirds the bones were perfectly healthy; that the most frequent cause of curvature resided in the intervertebral substances; these being, on the concave side of the curve, almost absorbed, and on the convex side preternaturally developed. As might be expected in these cases, the muscles on the convex side become lengthened, and degenerate in structure.—On this subject see *Hildebrandt's Anatomie*, B. ii. s. 155.

tebræ.—Each joint has a distinct capsular ligament, and a synovial membrane. The surfaces of the bones are coated with cartilage.

279. *Motions of the spine.*—Though but little movement can take place between any two contiguous vertebræ, (the atlas and axis excepted), yet the collective motion between them all is something considerable. The spine may be bent forwards, backwards, or on either side; and, in consequence of the great elasticity of the intervertebral cartilages, it returns spontaneously to its natural degree of curvature, like an elastic bow. The extent of its mobility is greatest in the cervical region, on account of the thickness of the fibro-cartilages, the small size of the vertebræ, the oblique direction of their articulations, and, above all, the horizontal position and the shortness of their spines. In the dorsal region there is very little mobility, on account of the vertical direction of the articular processes, and the manner in which the arches and the spines of the vertebræ overlap each other. In the lumbar region the spine again becomes more moveable, on account of the thickness of the intervertebral cartilages, and the horizontal direction of its spinous processes. The reason why the cervical and lumbar regions of the spine should be so much more moveable than the dorsal, must be at once obvious.

280. LIGAMENTS BETWEEN THE OCCIPITAL BONE AND THE TWO FIRST VERTEBRÆ.—The occiput is connected to the atlas by means of an *anterior* ligament which passes from the front border of the foramen magnum to the front part of the atlas. The thickest part of this ligament is in the middle. A *posterior* ligament extends in a similar manner from the posterior border of the foramen magnum to the arch of the atlas. Both these ligaments are sufficiently loose to allow the free movement of the head backwards and forwards.

The condyles of the occipital bone are connected to the corresponding articular surfaces of the atlas by capsular ligaments.

281. *Ligaments between the occipital bone and the axis.*—To see these, we must expose the spinal canal by removing the back of the occiput and the arches of the upper cervical vertebræ.

282. The *occipito-axoidean* ligament (apparatus colli ligamen-

tosus) may be regarded as a continuation of the posterior common ligament of the vertebræ. It is very thick and strong. It is attached to the basilar process of the occipital bone, descends perpendicularly over the odontoid process and its transverse ligament, with which it is intimately connected, and becoming gradually narrower is lost in the posterior common ligament.

The preceding ligament should be turned upwards, in order to expose the odontoid and transverse ligaments.

283. The *odontoid* or *check ligaments* (ligamenta alaria) are two very strong ligaments which proceed, one on either side, from near the summit of the odontoid process to the rough surface on the inner side of the condyle of the occiput. Their use is to prevent the rotation of the head beyond a certain distance. The *perpendicular* ligament ascends from the apex of the odontoid process to the margin of the foramen magnum.

284. Articulation between the atlas and the axis.—The odontoid process of the axis articulates in such a way with the front of the atlas that it constitutes a kind of pivot upon which the head and atlas rotate. The most important ligament is the *transverse.* It is a strong flat band which passes behind the odontoid process, and is attached on either side to the inner surface of the atlas, just above the lower articular processes. Thus it forms, together with the atlas, a kind of ring into which the odontoid process is received. If this transverse ligament be divided longitudinally, we observe that the odontoid process has a cartilaginous surface in front, and another behind, and that there are two distinct synovial membranes, one between the process and the atlas, the other between the process and the transverse ligament, for the purpose of facilitating the rotatory movement. The atlas and axis are connected in front and behind by thin loose ligaments, called, respectively, *anterior* and *posterior.* Their articular surfaces are nearly horizontal, in adaptation to the rotatory movement of the atlas.

285. Articulations of the ribs.—All the ribs, with the exception of the first and the two last, are articulated with the bodies of two vertebræ, and with the transverse processes. We

will first examine their connexion with the bodies of the vertebræ, and afterwards their connexion with the transverse processes.

The head of each rib presents two articular surfaces, which correspond to the little depressions observable on the sides of the bodies of the vertebræ. There are, therefore, two distinct articulations, each provided with a separate synovial membrane. The ligaments are :—1. An *anterior,* which connects the head of the rib with the vertebræ, and also with the intervening fibro-cartilage: this, on account of the divergence of its fibres, is often called the stellate ligament. 2. An *inter-articular,* which proceeds from the head of the rib to the intervertebral cartilage.

The tubercle of the rib presents a smooth surface which articulates with the transverse process of the lower of the two vertebræ, to which the head is connected. This articulation has a capsular and synovial membrane. The following ligaments fasten the rib to the transverse process :—1. The *posterior costo-transverse* passes from the apex of the transverse process to the rougher surface of the tubercle of the rib. 2. The *middle costo-transverse* connects the neck of the rib to the front surface of the transverse process. This may be seen by making a horizontal section through the rib and the transverse process. 3. The *anterior costo-transverse* ascends from the neck of the rib to the lower border of the transverse process above it. This ligament is absent in the first and last ribs.

The head of the first rib differs from the rest in that it articulates with a single vertebra, the first dorsal. The interarticular ligament is consequently absent.

The eleventh and twelfth ribs articulate each with a single vertebra, and are not connected to the transverse processes.

286. *Connection between the cartilages of the ribs and the sternum.*—The cartilages of all the true ribs are received into slight concavities on the side of the sternum. In young subjects we find that the cartilages of the six lower true ribs have distinct articulations provided with synovial membranes. They are secured in front and behind by strong ligamentous fibres, which proceed from the cartilages and radiate upon the sternum, crossing those of the opposite side.

The *costal cartilages from the sixth to the tenth* are connected by ligamentous fibres, and we frequently find that their contiguous surfaces are lined by a synovial membrane.

The *pieces of the sternum* are, as it were, glued together by fibro-cartilage, and they are connected by strong ligamentous fibres which spread over their anterior and posterior surfaces.

287. Articulation of the lower jaw.—The condyle of the lower jaw articulates with the glenoid cavity of the temporal bone. The joint is provided with an interarticular fibro-cartilage and with external and internal lateral ligaments.

a. The *external lateral ligament* extends from the tubercle of the zygoma downwards and backwards to the neck of the condyle of the jaw.

b. The *internal lateral ligament* is a very long one. It consists of a broad flat band which extends from the spinous process of the sphenoid bone to the border of the dental foramen on the inner side of the jaw (see § 84).

c. The *interarticular fibro-cartilage* is of an oval form, and thicker at the margin than at the centre. It is connected on the outer side to the external lateral ligament, and in front some of the fibres of the external pterygoid muscle are inserted into it (see § 81).

There are *two synovial membranes* in the joint. The larger and looser of the two is situated between the glenoid cavity and the fibro-cartilage. The other is interposed between the fibro-cartilage and the condyle of the jaw. They sometimes communicate through a small aperture in the centre of the fibro-cartilage.

The form of the articulation of the lower jaw admits of motion in several directions,—upwards and downwards, forwards and backwards, and from side to side. A rapid succession of these movements takes place during mastication; so that it may be said that during this act the condyles of the jaw describe circular movements upon the glenoid cavity of the temporal bone; and the intervening fibro-cartilage enables them to do so with much greater facility.

END OF PART II.

THE DISSECTION OF THE ABDOMEN.

1. THE abdomen is divided into regions, in order that the situation of the organs contained in it may be more easily described. These regions being purely arbitrary, we cannot wonder that anatomists differ as to their number and boundaries. For all practical purposes, the following division, handed down from the ancient Greek authors, is sufficiently convenient. An imaginary horizontal line is drawn across the abdomen on a level with the cartilage of the 9th rib; another on a level with the anterior spine of the ilium. That part of the cavity situated above the upper line is called the *epigastric* region; that below the lower one, the *hypogastric;* while the space included between the lines is termed the *mesogastric* or umbilical. These again are subdivided thus:—the sides of the epigastric region, beneath the costal cartilages, are termed respectively the right and left *hypochondria,* and the depression in front, just below the ensiform cartilage, is called the *scrobiculus cordis,* or the pit of the stomach. The sides of the umbilical region are named the ilia or flanks, and the back part, the loins. The sides of the hypogastric region are familiarly known as the groins, while the middle of it is called the *pubes.*

An incision should be made from the sternum to the pubes, another from the anterior spine of the ilium to the umbilicus, and a third from the umbilicus obliquely outwards, over the cartilages of the ninth and tenth ribs, halfway up to the axilla. The skin should then be dissected from the subjacent adipose and cellular tissue, commonly called the superficial fascia.

2. *Superficial fascia.*—The subcutaneous tissue of the abdomen presents the same general characters as that of other parts, and varies in thickness according to the condition of the individual. When carefully examined, more especially at the lower part of the belly, we find that it admits of separation into two layers, and that the subcutaneous vessels and nerves ramify between them. Respecting the more superficial of these layers, there is nothing to be

observed, except that it contains the fat. The deeper layer is connected along the line where the abdomen joins the thigh, to the muscular fascia,—or, in other words, to the crural arch; but it is loosely continued over the spermatic cord, and the scrotum, into the perineum. These points deserve attention, because they explain how it happens that the urine, when extravasated into the scrotum, readily makes its way over the spermatic cord on to the surface of the abdomen; but from this it cannot travel down the thigh, on account of the connexions of the fascia above alluded to.

3. *Superficial blood-vessels and glands.*—Between the layers of the superficial fascia on the groin and the upper part of the thigh, there are several absorbent glands, and small blood-vessels. The glands are named, according to their situation, inguinal and femoral. With the latter we are not at present concerned. The inguinal are often so small as to escape observation. They are about four or five in number, and of an oval form, with their long axis corresponding to the line of the crural arch. They receive the absorbents from the wall of the abdomen, from the scrotum and penis, and are therefore liable to be affected in diseases of these parts.

The *superficial arteries* in the neighbourhood arise from the femoral. One, called the *epigastric,* ramifies over the lower part of the abdomen; another, called the *pudic,* crosses the spermatic cord, and is distributed to the skin of the penis and scrotum, while a third, the *circumflexa ilii,* ramifies towards the spine of the ilium. These subcutaneous arteries, the pudic especially, are in some subjects much larger than usual, and often occasion a free hemorrhage after the first incision in the operation for strangulated hernia.

The veins, corresponding to these arteries, join the saphena vein of the thigh. Under ordinary circumstances they do not appear in the living subject; but, when any obstruction takes place in the inferior vena cava, they then become enormously enlarged and tortuous, and constitute the chief channels through which the blood would be returned from the lower limbs*.

* A cast, in illustration of this, is preserved in the museum of St. Bartholomew's Hospital.

4. *Cutaneous nerves.*—The skin of the abdomen is supplied with nerves after the same plan as that of the chest; namely, by lateral and anterior branches divided from the intercostal nerves.

a. The *lateral cutaneous nerves* come out between the digitations of the external oblique muscle, in company with small arteries, and then divide into anterior and posterior branches. It should be observed, however, that the lateral branch of the twelfth dorsal nerve is larger than the others, and that it passes over the crest of the ilium for the supply of the skin of the buttock. The corresponding branch of the first lumbar nerve has a similar distribution; and its size is generally in inverse proportion to that of the twelfth dorsal.

b. The *anterior cutaneous nerves* are seen coming with their little arteries through the sheath of the rectus muscle. They are not only much smaller than the lateral nerves, but their number and place of exit is less regular. That which comes through the external abdominal ring, as well as another which comes through the wall of the abdomen just above it, is derived from the first lumbar nerve. These, however, are but repetitions of the others, and are intended for the supply of the skin of the groin and scrotum in the male, and the labium pudendi in the female.†

5. *Muscles of the abdominal wall.*—Our next object should be to examine the abdominal muscles. There are three of them, on either side, arranged in strata, and severally named after the direction of their fibres,—the external oblique, the internal oblique, and the transversalis. They all terminate in front in strong aponeuroses, which are so arranged as to form a sheath for a broad perpendicular muscle called the rectus. Each of these muscles we will now successively describe.

a. The *external oblique* arises from the eight or nine lower ribs, by as many pointed bundles, termed its "digitations." The upper five of these fit in with similar bundles of the serratus magnus, and are obvious even during life; the three lower ones correspond

† These two cutaneous nerves are sometimes called, respectively, the "ilio-hypogastric" and "ilio-inguinal."

in like manner with the origin of the latissimus dorsi, but they cannot be distinctly seen unless the body be turned on the side. By far the greater part of the muscle descends obliquely forwards, and terminates on the aponeurosis of the abdomen; the remainder proceeds almost perpendicularly from the last ribs, and is inserted into the anterior two-thirds, more or less, of the crest of the ilium.*

The *aponeurosis* of the external oblique increases in strength, breadth, and thickness, as it approaches the lower margin of the belly, this being the situation where the greater pressure of the viscera requires the most effective support. The tendinous fibres of which it is composed take the same direction as those of the muscle; they do not, however, stop at the middle line, or linea alba, but cross to a considerable distance over those of the opposite side; a structure which, of course, makes the aponeurosis all the stronger. Along the line of junction of the abdomen and thigh, we have to observe that the aponeurosis extends from the anterior spine of the ilium to the spine of the pubes, and forms an arch over the intermediate bony excavation. This, which is appropriately termed *the crural arch*,† transmits the great vessels of the thigh, with certain muscles and nerves, which will be examined hereafter. Near the pubes there is an opening in the aponeurosis, of considerable size, for the passage of the spermatic cord in the male, and the round ligament of the uterus in the female. It is called the external abdominal ring. But of this, as well as of the crural arch, we may postpone more particular examination till we come to the description of the parts concerned in inguinal hernia.

The external oblique should be carefully detached from the ribs and the crest of the ilium, and then turned forwards as far as this

* From its position and the direction of its fibres, it is manifest that the external oblique represents, in the abdomen, the external intercostal muscles of the chest.

† This was first described by Fallopius, an Italian anatomist, in his "Observationes Anatomicæ," published in 1561. It was subsequently described by Poupart in 1705, in the "Mém. de l'Acad. de Paris," and is now commonly called in the schools "Poupart's ligament."

can be done without injuring its aponeurosis or the crural arch. In this way the second muscular stratum will be exposed.

b. The *internal oblique* is attached to the outer half of the crural arch, to the anterior two-thirds of the crest of the ilium, and indirectly to the transverse processes of the lumbar vertebræ, by means of a thin aponeurosis which cannot at present be seen. From these several attachments the fibres ascend more or less obliquely, and are inserted partly into the abdominal aponeurosis and partly into the cartilages of the three or four lower ribs.*

The internal oblique should be detached from the ribs, from the loins, and from the crest of the ilium; but that portion of it connected to the crural arch must not for the present be disturbed. In removing the internal oblique, we are very apt to cut away at the same time the transversalis. To avoid this mistake we should dissect near the crest of the ilium, and endeavour to find an artery which runs between the muscles, and serves as a guide. This artery, called the deep *circumflexa ilii,* proceeds from the external iliac, and is intended for the supply of the abdominal wall. We notice that it skirts the crest of the ilium, giving off branches of considerable size to the muscles. Beneath the internal oblique, then, we bring into view the transversalis, and the continuations of the intercostal nerves and vessels. These it is desirable to preserve.

c. The *transversalis* arises from the outer half of the crural arch, from about the anterior two-thirds of the crest of the ilium, from a fascia attached to the transverse processes of the lumbar vertebræ, and, lastly, from the inner surfaces of the six or seven lower costal cartilages, by as many digitations which correspond with those of the diaphragm; but these cannot at present be seen. From this manifold origin the fibres proceed horizontally forwards, and terminate in the abdominal aponeurosis.

d. The *rectus* extends perpendicularly along the front of the belly, and is enclosed in a sheath formed by the collective aponeuroses of the lateral muscles of the abdomen. To expose the muscle,

* The internal oblique represents in the abdomen the internal intercostal muscles of the chest.

therefore, we must slit up its sheath from end to end. It arises by a flat tendon from the symphysis, and from more or less of the upper part of the pubes. The fibres ascend, gradually expanding, and are inserted into the fifth, sixth, and seventh costal cartilages. We have to notice across the muscle certain tendinous intersections called *lineæ transversæ,* which are, in point of fact, nothing but incomplete repetitions of the ribs in the wall of the abdomen.* Their number varies in different instances from three to five, but there are always more above than below the umbilicus.

There is something to be said respecting the manner in which the sheath of the rectus is formed. The front of the sheath comprises the aponeurosis of the external oblique, and half the thickness of that of the internal oblique;† while the back of the sheath comprises the aponeurosis of the transversalis, and the other half of the internal oblique. This, however, applies only to the upper three-fourths of the muscle; the lower fourth has no sheath behind, for all the aponeuroses pass in front of it.

e. Linea alba.—Along the middle line of the belly the several aponeuroses of the muscles meet and decussate so as to form a tendinous structure, extending from the sternum to the pubes. This is the *linea alba:* it is obviously but a continuation of the sternum deprived of its earthy matter, in adaptation to the functions of this part of the body. A little below the middle of it is situated what was in the fœtus the opening for the passage of the umbilical vessels. After birth, the vessels being no longer required, the opening gradually closes, and becomes plugged by their fibrous remains.

Since the linea alba is the thinnest part of the abdomen, and is free from blood-vessels of any size, it is chosen as a safe line for tapping in dropsy, and for puncturing the bladder in retention of urine.

f. Pyramidalis.—This little muscle is situated near the pubes, close to the linea alba, and has a little sheath of its own. It arises

* Some animals—*e. g.* the crocodile—have abdominal ribs.

† The line where the internal oblique splits—namely, along the outer border of the rectus—is called the *linea semilunaris.*

from the upper part of the pubes in front of the rectus, and terminates in a pointed manner about midway between the pubes and the umbilicus. It is said to be of use in tightening the linea alba, but it does not appear to have any special purpose in the human subject, for it is sometimes deficient on one or even both sides.

By dividing the rectus transversely near the umbilicus, and raising it from its position, we have a complete view of the manner in which the sheath is formed; and we observe, too, that this is very indistinct behind the lower fourth of the muscle. Ramifying in the substance of the muscle there is a large artery, called the epigastric, a branch of the external iliac; and also the continuation of the internal mammary, which descends from the chest.

6. *Nerves of the abdominal wall.*—Respecting these nerves, it is sufficient to mention that they are the continuations of the six lower intercostal nerves, and of the first lumbar. They have all the same general course and distribution. We trace them running forwards between the internal oblique and transversalis towards the rectus. They furnish branches to the several muscles, and each gives off its lateral and anterior cutaneous branch (see § 4). Many of them are accompanied by small arteries.

Action of the abdominal muscles.—In consequence of their stratified arrangement, and the different direction of their fibres, the abdominal muscles are admirably adapted to answer many important purposes:—1. They are the principal muscles of expiration; 2, by compressing the viscera in conjunction with the diaphragm, they are the chief agents in the expulsion of the fæces, the urine, and also in vomiting, sneezing, laughing, coughing, and so forth; 3, they act, each in their own way, as movers of the trunk: *e. g.* the right external oblique, co-operating with the left internal oblique, can draw the trunk towards the left side, and *vice versâ*. The rectus, too, co-operates in raising the body from the horizontal position, as any one may ascertain by laying the hand on the abdomen while rising from the ground.

EXAMINATION OF THE PARTS CONCERNED IN INGUINAL HERNIA.

7. Presuming that the reader has proceeded so far in the examination of the abdominal wall, we now recommend him to turn his especial attention to the anatomy of the parts through which an inguinal hernia may protrude.

The testicle, originally formed in the lumbar region, subsequently passes through the wall of the abdomen into the scrotum: its nutrient apparatus and excretory duct, drawn down after it, collectively constitute the spermatic cord; and the passage through which it comes from the abdomen is called the inguinal canal. This canal is not direct, but oblique, evidently that the abdominal wall may be more likely to resist protrusion of the viscera. Now we have seen that the wall of the abdomen is composed of strata of different structures; and we shall presently find that the spermatic cord, as it passes successively through each stratum, derives from each a covering similar in structure to the stratum itself. Of these strata there are only three: the first—that is, the aponeurosis of the external oblique,—we shall call the aponeurotic stratum; the second—that is, the internal oblique and transverse muscles,—we shall call the muscular stratum; the third—namely, the fascia which lines the under surface of the transverse muscle,—we may, for want of a better name, call the fascial stratum. The most intelligible way of investigating the subject is to examine each stratum as it appears on dissection, and then to consider the inguinal canal as a whole. First, then, of the aponeurotic stratum.

8. *Aponeurotic stratum.*—We are already familiar with the aponeurosis of the external oblique, and that its lower border, extended from the spine of the ilium to the spine of the pubes, constitutes the crural arch. It remains for us now to examine more in detail the opening in the aponeurosis which gives passage to the spermatic cord; in other words, the *external abdominal ring,* or the lower aperture of the inguinal canal. This ring, then, is situated immediately above and to the outer side of the spine of the

pubes: its size and shape vary a little in different individuals. Without pretending to minute accuracy, we may say that it is an oval opening, with the long axis directed obliquely downwards, and that it will admit the passage of a finger.* These remarks, of course, apply exclusively to the male subject; in the female the opening is much smaller, and transmits only the round ligament of the uterus. The sides of the opening are usually called its pillars or columns,† and their respective attachments should be thoroughly investigated. The internal of the two pillars is attached to the front of the pubes, not only of its own side, but also of the opposite; so that there is a decussation of aponeurotic fibres in front of the symphysis just as there is in the linea alba. The external pillar, however, is altogether stronger and much more firmly secured, because there is a greater strain upon it. We find that it has as many as three points of attachment, each of which, being considered as a ligament, has accordingly received a special name. One, and perhaps the strongest attachment, is to the spine of the pubes (Poupart's ligament). The second extends for nearly an inch along the crest of the pubes (Gimbernat's ligament). The third, and weakest, consists of a few fibres, which pass beneath the internal pillar to the linea alba, and are, in fact, continuous with the aponeurosis of the opposite side (this is commonly called the triangular ligament). There can be no objection to our calling these several ligaments by separate names, provided we understand that they are nothing more than the attachments of the outer pillar of the ring.

For some distance above the opening we observe that the cross fibres of the aponeurosis (alluded to at § 5, *a*) are very strongly marked. These cross fibres, which round off the upper margin of

* In order to ascertain in the living subject whether the ring be free or otherwise, the best plan is to push the thin skin of the scrotum before the finger; then, by tracking the cord, we can readily pass the finger into the ring behind the fat which covers the pubes.

† These and many other expressions in the language of anatomy may appear to us at first rather far-fetched or even affected, but we soon conform to them as quite natural and proper, because universally received amongst those whom they most concern.

the opening, are indeed so conspicuous that anatomists have called them the *intercolumnar bands*. Their purpose plainly is to prevent the ring from enlarging.

It is only necessary to add, that the spermatic cord rests upon the outer pillar, and that it receives from the margin of the opening a covering, commonly called *the spermatic fascia*.

9. *Muscular stratum.*—To examine the muscular stratum we must reflect the aponeurosis of the external oblique. This is best done by making a transverse incision through it from the spine of the ilium to the linea alba, and another at right angles to the first, down to the pubes. We can thus turn down a triangular flap of the aponeurosis without injuring either the external ring or the crural arch. This done, the muscular stratum is fairly exposed. Now this stratum consists of the combined fibres of the internal oblique and transverse muscles: these, so far as our present subject is concerned, may be considered as one, having the same origin, direction, and insertion. Their origin is from the outer half more or less of the crural arch; their direction is transversely towards the mesial line, and they terminate upon a thin aponeurosis which is inserted into the upper part of the pubes and the linea alba. It is important to observe that this aponeurosis is situated immediately behind the external ring, plainly for the purpose of strengthening the abdominal wall just at a part where, without such provision, the liability to hernia would have been very great.

The spermatic cord passes through this muscular stratum, and derives from it a covering, called the *cremaster*, or suspensory muscle of the testicle. The fibres of the cremaster are thin and pale, or the reverse, according to the condition of the subject. Its component bundles, arising from the crural arch, descend most of them in front of the cord, and then arch up again towards the pubes. Thus they form a series of loops of different lengths; some reaching only as low as the external ring, others lower still, while the lowest cover the tunica vaginalis of the testicle. In very muscular subjects we may sometimes succeed in tracing some of the returning fibres up to the pubes, or even the sheath of the rectus; but this is quite the exception.

10. *Fascial stratum.*—This third and last stratum, let it be un-

derstood, is nothing more than the fascia which lines the transverse muscle. For many reasons it is most advantageous to examine it from behind; we should therefore turn down a triangular flap of the abdominal wall, just as was done with the aponeurosis of the external oblique.

On the inner surface of the flap, thus reflected, is the smooth peritoneal lining of the abdomen. If the parts be all kept together and made as tense as natural, we may notice that the peritoneum is raised into a sort of fold by a thick fibrous cord,* which runs up rather obliquely towards the umbilicus. This cord is nothing but the impervious remains of the umbilical artery. If the peritoneal fold be well marked, it appears triangular with the base below, and occasions two pouches one on either side of it. The depth and distinctness of these pouches, it need hardly be said, will be in proportion to the prominence of the fold itself; on the other hand, if it so happen that the cord be closely attached to the abdominal wall, then there will be no fold or pouch at all.†

To proceed, then, with our subject, the peritoneum must be removed from the abdominal flap. This is done easily enough, for it is loosely connected to the abdominal wall by an abundance of soft cellular tissue, which generally contains a considerable quantity of fat. A tissue of a similar kind connects the peritoneum to the iliac region; and this accounts for the facility with which the peritoneum can be extended so as to envelop even the largest herniæ. The fascia lining the under surface of the transverse muscle was first accurately described by Sir A. Cooper, and called by him the *fascia transversalis*. It is attached to the line of the crural arch, thence ascends, and is gradually lost on the under

* We must take care not to confound the cord in question with what is called the *urachus*. This is another cord, a remnant of embryonic life, which ascends from the bladder directly behind the linea alba to the umbilicus.

† These peritoneal pouches are considered to favour the occurrence of hernia, and so much importance has been attached to them by some continental surgeons, that they have divided inguinal herniæ into external and internal, according as the protrusion takes place in the outer or the inner fossa.

surface of the abdominal wall. The opening in the fascia through which the spermatic cord passes is called the internal abdominal ring.* This must be accurately examined. First, it is important to be familiar with its precise situation. It corresponds with a point midway between the anterior superior spine of the ilium and the symphysis pubis, and about two-thirds of an inch above the crural arch. As to its shape, it is like anything but a ring, in the strict sense of the word. We had better introduce the little finger or the handle of the scalpel into it, and judge for ourselves. We shall find that it has a defined margin on the pubic side, but none on the iliac, and that on the whole it has rather a funnel-shaped aspect.

In its passage through this opening the spermatic cord receives from the margin of it its first covering, thin and delicate it is true, but still a covering.† The chief point of interest concerning the internal ring is that the epigastric artery ascends close by its inner border. This very important vessel we shall presently describe in detail.

11. Having thus investigated analytically the several strata through which the spermatic cord passes, the learner will do well to replace them in their natural position, and build them up as it were, so as to examine the inguinal canal as a whole. He will perceive that its direction is not exactly horizontal, but rather obliquely downwards and inwards. Its length in a well-formed adult male is from one and a half to two inches, or three inches if we include the openings. It is necessary to be aware, however, that in young subjects the outer and inner apertures nearly correspond, so that the cord escapes through a ring rather than a canal.

12. *Course and relations of the epigastric artery.*—In a practical point of view this is one of the most important arteries in the body. It arises from the external iliac, just before this vessel passes under the crural arch. It ascends inwards, forms a gentle

* Or the inner aperture of the inguinal canal.

† Sometimes called the infundibuliform fascia, from its peculiar appearance when viewed from the abdominal side. But after all it is nothing but condensed cellular membrane, and under healthy conditions so thin and transparent as scarcely to deserve a name.

curve round the inner side of the internal abdominal ring, and consequently on the inner side of the spermatic cord, and then entering the rectus muscle is gradually lost in it. In the more important part of its course it lies between the peritoneum and the fascia transversalis; afterwards it enters the sheath of the rectus. The artery is accompanied by two veins, of which the larger is constantly found on the inner side of it. They terminate generally by a single trunk in the iliac vein.

a. Of the *branches* of the epigastric artery the most important is the *pubic*. It runs inwards, just behind the crural arch, to the pubes, and it derives its chief practical interest from the fact that it is liable to be wounded in dividing the stricture in femoral hernia.* But its size varies in different subjects, and is sometimes so small as to escape observation. The second branch is the *cremasteric*. It supplies the coverings of the cord, and chiefly the cremaster muscle. After giving off other unnamed muscular branches, the main trunk terminates in the rectus by minute inosculations with the internal mammary.

Such is a brief outline of the anatomy of the parts concerned in inguinal hernia. This description applies equally to the female, provided the round ligament be substituted for the spermatic cord. Of course the inguinal canal is proportionably smaller, and there is no cremaster. We shall close the subject by a few practical remarks.

13. *Nomenclature of the several kinds of inguinal hernia.*—If a piece of intestine escape along the inguinal canal with the cord, and protrude through the outer ring, it is called an oblique inguinal hernia. Supposing the intestine to stop in the inguinal canal, it is called an internal or incomplete inguinal hernia; such a one is generally of small size, and often difficult of detection. Lastly, if a portion of intestine escape at once through the external ring, then it is called a direct inguinal hernia.

* There is a preparation (No. 83. Ser. 17) in the museum of St. Bartholomew's Hospital, quite to the point. The patient had profuse hemorrhage, which commenced five hours after the operation, and he died with peritonitis.

14. *Coverings of the different herniæ.*—An oblique inguinal hernia must necessarily have all the coverings of the cord. Beneath the skin, therefore, and the subcutaneous tissue, there will be

1. The spermatic fascia, derived from the aponeurosis of the external oblique.

2. The cremaster muscle, derived from the internal oblique and transversalis.

3. The infundibuliform fascia, derived from the fascia under the transversalis muscle.

The incomplete inguinal hernia will be covered by

1. The aponeurosis of the external oblique.
2. The cremaster.
3. The infundibuliform fascia.

The direct inguinal hernia will be covered only by

1. The spermatic fascia.
2. The fascia transversalis.*

In all cases, or at any rate with very few exceptions, the immediate investment of the intestine is the peritoneum. This constitutes the sac of the hernia. The opening of the sac, communicating with the abdomen, is called its mouth, then comes the neck, and lastly, the body or expanded part of the sac.

15. *Position of the spermatic cord in reference to the hernia.*—The spermatic cord is generally situated behind and rather on the outer side of the hernial sac. But instances sometimes occur in which there is a different arrangement, and such deviations are easily explained. Since the spermatic vessels and the hernial swelling are more or less connected by cellular tissue, and included, as it were, in a common sheath, we can have no difficulty in understanding that the gradually increasing tumor may separate the component parts of the cord, so that one or other of them may come to lie on the front of the swelling. A similar displacement is sometimes produced by an old and large hydrocele on the same principle; the increase of the watery tumor affecting the spermatic

* What becomes, it may be asked, of the aponeurotic insertion of the muscular stratum? The hernia slips between its fibres.

vessels and the vas deferens in the same way as the growth of the rupture. For this reason we ought always, in large herniæ, to be cautious in cutting down upon the sac that we do not divide any of the displaced components of the cord. Mr. Hey mentions, as a warning, that he once divided the vas deferens.* Of course there is scarcely any danger of the kind so long as the hernia continues of moderate size.

16. *Seat of stricture.*—The stricture may be seated either at the upper opening of the inguinal canal, or at the lower opening, or in the intermediate muscular part. Sometimes there is a sort of double stricture, one at the upper and another at the lower opening.

The stricture, however, may be caused by the mouth of the sac itself, independently of the parts outside it; for it occasionally happens that the peritoneum becomes thickened and indurated, and sufficiently unyielding to strangulate the protruded parts. Such changes are liable to be produced by the pressure of a truss.

17. *Direction in which the stricture should be divided.*—We cannot do better than adhere to the golden rule laid down by Sir A. Cooper, namely, to divide the stricture, in all cases, directly upwards.

18. *Changes produced by an old and large hernia.*—Whoever has the opportunity of dissecting an old hernia of some size, may observe that the obliquity of the inguinal canal is destroyed. The constant dragging of the protruded viscera gradually brings the upper opening nearer to the lower, so that at last the one gets quite behind the other, and there is a direct opening into the abdomen. But the position of the epigastric artery with regard to the mouth of the sac remains unaltered. The effect of this continual dragging is such that we seldom meet with an oblique hernia of any standing, where the natural distance between the two openings is preserved.

It is observable too in herniæ of long standing that all its coverings undergo a change. They become thickened and hypertrophied to such an extent, and so altered from what they once were, that they scarcely look like the same parts.

* Practical Observations, p. 146.

WHAT IS SEEN ON OPENING THE ABDOMEN.

19. Let us now fairly expose the contents of the abdomen by a crucial incision, and just take a general survey of the viscera before they are disturbed from their relative position.

In the right hypochondrium the liver is seen projecting more or less below the cartilages of the ribs, and the fundus of the gall-bladder below the edge of the liver, near the end of the ninth costal cartilage. In the left hypochondrium is seen more or less of the stomach. Across the umbilical region there is seen a portion of the large intestine called the transverse colon; from this there descends a broad fold of peritoneum, called the great omentum, looking like a curtain of fat over the convolutions of the small intestines; but the breadth of this fold varies in different instances, and sometimes it is quite contracted and crumpled. The lower part of the belly and part of the pelvis is occupied by the small intestines. The urinary bladder is not apparent, unless it be distended sufficiently to rise out of the pelvis. In the right iliac fossa we probably see the caput coli, or the commencement of the large intestine; but the ascending part of the large intestine in the right lumbar region, and the descending part of it in the left, are not visible unless when distended: they lie contracted at the back of the abdomen.

Such and so much of the viscera are usually seen on opening the abdomen; but, of course, a certain latitude must be allowed to this statement. Sometimes more of one organ appears and less of another, according as this or that is distended or hypertrophied. Much depends also upon the amount of pressure which the ribs have undergone during life; so that, all things considered, we seldom see the parts in any two bodies precisely in the same position.

20. *Particular position of each viscus.*—We should now examine the position of each viscus separately; and, first, that of the liver.

a. The *liver* occupies the whole of the right hypochondrium, and extends over the epigastric region more or less into the left.

Unless the individual be very corpulent, we can ascertain during life the extent to which the liver projects below the costal cartilages, and the general dimensions of the organ may be tolerably well told by percussion. Its under surface overlays part of the stomach, of the duodenum, and of the transverse colon : its upper surface is convex, and accurately adapted to the arch of the diaphragm. To this muscle we find that the liver is connected by folds of peritoneum, commonly called its ligaments. One of these, nearly longitudinal in direction, and called the *suspensory*, or, from its shape, the *falciform* ligament,* is situated a little to the right of the mesial line. The free edge of it in front contains the impervious remains of the umbilical vein, now called the *round* ligament. The suspensory ligament, if traced backwards, leads to another broad fold extending horizontally from the diaphragm to the posterior border of the liver : this constitutes the *lateral* ligament, right or left, according as we trace it on one or other side of the falciform ligament.†

b. Respecting the *gall-bladder*, all we need notice at present is, that it is closely confined by the peritoneum in a slight depression on the under surface of the liver, and that its lower end or fundus projects more or less beneath the cartilage of the ninth rib. This is not altogether unimportant in a practical point of view : it sometimes happens that the gall-bladder, in consequence of some obstruction to its duct, becomes unusually distended, and, under such circumstances, occasions a swelling below the margin of the ribs, which might possibly be mistaken for an hepatic abscess.‡ The close proximity of the gall-bladder to the duodenum and the transverse colon explains the occasional evacuation of gall-stones into one or other of these intestines.

* Between the layers of the suspensory ligament, in a well-injected subject, numerous branches pass from the phrenic artery to the liver. Along this fold, too, the absorbents from the upper surface of the liver proceed to join the glands in the anterior mediastinum.

† The junction of the lateral and the falciform ligaments is described by authors as the *coronary* ligament.

‡ See cases in point recorded by Andral, Clin. Méd. tom. iv. ; and Graves, Dublin Hospital Reports, vol. iv.

c. Stomach.—The more capacious part of the stomach is situated under the shelter of the left hypochondrium, and, when distended, occupies nearly the whole of it; but the narrow or pyloric end extends rather obliquely across the epigastrium, more or less into the right hypochondrium, where it is overlapped by the liver. The position of the great end of the stomach explains the peculiar sonorousness which percussion frequently elicits over the left hypochondrium, and even for some distance up the side of the chest; so that, when the stomach is large and flatulent, it is often very difficult to ascertain whether the mixture of air and liquid which produces the sound be contained in the abdomen or the chest. The pressure of the over-distended stomach upon the heart accounts for the irregular action of this organ observable in some cases of indigestion.

d. Spleen.—The stomach naturally leads us to the spleen. This organ is situated deep in the left hypochondrium, between the stomach and the ninth, tenth, and eleventh ribs. Its outer surface is free and convex, so as to correspond with the diaphragm and the ribs; its inner surface, where its great vessels enter it, is concave and connected to the great end of the stomach by a peritoneal fold called the gastro-splenic omentum. Generally, too, the spleen is connected by another small peritoneal fold to the diaphragm.*

21. *General outline of the course of the intestines.*—We should now trace the course of the alimentary canal from the stomach to the anus, so far as this can be done without injury to its connections. A small part of it only is immoveably fixed. Though all the rest of the canal can be moved about with facility, yet it is so connected by folds of peritoneum to the back of the abdomen that it cannot become entangled.

a. The first part of the canal, termed the *intestinum duodenum,* because it is about twelve inches long, takes a very curious course. Although the whole of this part cannot at present be fairly exposed, yet we trust the learner will be able to follow our description of it. Commencing, then, at the pylorus, the duodenum ascends rather

* Every now and then we find in the gastro-splenic omentum one or more little spleens in addition to the large one.

obliquely as high as the neck or narrow end of the gall-bladder; then, making a sudden bend, it descends in front of the right kidney; and, lastly, making another bend, it crosses the spine rather obliquely towards the left side of the second lumbar vertebra; here the canal takes the name of *jejunum*, and the commencement of this part of the intestine is at once seen by raising the transverse colon. Thus, then, it appears that the duodenum describes a sort of horse-shoe curve. The concavity of this curve is towards the left, and embraces the head or larger end of the pancreas. For convenience of description, it is usual to divide the duodenum into an ascending, a descending, and a transverse portion. The first is completely covered by the peritoneum, and is comparatively loose, that the motions of the stomach may not be restricted; the second and third are only covered by peritoneum in front, and are immoveably fixed, for very good reasons, to the back of the abdomen.*

b. Pursuing its course from the left side of the second lumbar vertebra, the intestinal canal next forms a number of convolutions, which are loosely connected to the spine by a broad peritoneal fold termed the *mesentery*. Of these convolutions, the upper two-fifths constitute the *intestinum jejunum;* the lower two-fifths the *intestinum ileum*. This is merely an arbitrary division; for there is no definite limit between them: but the character of the bowel gradually changes—that is, it becomes less vascular, has fewer folds of the lining membrane, and its coats are therefore less substantial to the feel.

c. In the right iliac fossa, the small intestine opens into the left side of the colon; here the *large intestine* begins. Immediately below the junction we observe that the large intestine is expanded into a kind of blind pouch, called the *cæcum* or the

* There are two reasons why the second and third parts of the duodenum should be fixed and have no mesentery: first, if the duodenum had been loose, it would have fallen down like the other intestines, and so have disordered the stomach by dragging it down with it; secondly, had it been loose, it would have been apt to have stretched the bile and pancreatic ducts, and the flow of bile through them would every now and then have been obstructed.

caput coli. Into the back part of this pouch there opens a little independent tube closed at the other end, called the *appendix vermiformis.* This tube is generally three inches long, about as thick as a tobacco-pipe, and is either coiled up behind the cæcum, or else is connected to it by a peritoneal fold, so as to hang loose in the pelvis.

The commencement of the large intestine is generally confined by the peritoneum to the iliac fossa, in which it lies.* Tracing it onwards from this point, we find that it ascends in front of the right kidney, and then, crossing the umbilical region towards the left side,† descends in front of the left kidney‡ into the iliac fossa, where it curves like the letter S. These successive portions of the large intestine are termed respectively the ascending, transverse, descending, and sigmoid parts of its course. Lastly, the bowel enters the pelvis on the left side of the sacrum, and here takes the name of *rectum.* This term, so far as concerns the human subject, is misapplied; the canal runs anything but a straight course through the pelvis, for it curves so as to adapt itself to the sacrum.

Looking at the entire course of the colon, we observe that it forms an arch, of which the concavity embraces the convolutions of the small intestines.

22. *Peritoneum.*—Since a certain range of motion is necessary to the function of the abdominal viscera, they are provided with a serous membrane, called the peritoneum. This membrane not

* But this is not invariably so, The bowel is, in some subjects, connected to the fossa by a fold of peritoneum or a "*meso-cæcum.*" We have seen this fold sufficiently loose to allow the caput coli to travel quite over to the left iliac fossa.

† This transverse part of the colon, in some instances, makes a coil behind the stomach to the diaphragm; such a state of things, when the bowel happens to be distended, is apt to give rise to symptoms of diseased heart. See some observations in point by Dr. Copland, in Lond. Med. Gaz., vol. v. 1847, p. 660.

‡ The contiguity of the ascending and descending colon to the right and left kidney, respectively, explains the occasional bursting of renal abscesses into the intestinal canal.

only facilitates their movements, but maintains each in its proper place, and connects them together in such a manner that they never become disarranged. Although its texture is thin, and apparently delicate, yet it is so tough, that if a portion of it were removed and stretched across a hoop, it would support a weight of from forty to fifty pounds without giving way. That it is elastic too, is proved by the rapidity with which it recovers itself after being distended by dropsy, pregnancy, hernia, &c.

The plan of the peritoneum is like that of all other serous membranes; that is, it forms a closed sac, one part of which lines the containing cavity, the other the contained organs. These are respectively termed the parietal and the visceral layers. There is nothing between them,—or, in other words, inside the sac, but just sufficient moisture to lubricate its smooth and polished surface. The viscera, then, are all outside the sac. Some lie altogether behind it, as, *e. g.* the pancreas and kidneys; others push the visceral layer before them, so as to give rise to membranous folds; and the greater the fold, the greater, of course, will be the mobility of the viscus which occasions it. The vessels and nerves of the viscus must run up to it through the fold, for they can get to it in no other way.

We had better, in the next place, make ourselves acquainted with the names of the several folds which connect the viscera either to each other or to the back of the abdomen. This done, we should then endeavour to trace the peritoneum as a continuous membrane.

a. Mesentery.—This is the great fold which connects the small intestines to the back of the abdomen. To see it we ought to raise the omentum and the transverse arch of the colon. We may then observe that its attached part or root extends from the left side of the second lumbar vertebra across the spine to the right iliac fossa. The loose part of the mesentery curves, as it were, like a ruffle, and encloses the small intestine from the beginning of the jejunum to the end of the ileum. Between its layers, there are the mesenteric vessels, nerves, and glands.

b. Transverse meso-colon.—This is the broad fold which connects the transverse colon to the back of the abdomen. It forms

a sort of partition, dividing the abdomen into an upper compartment, containing the stomach, liver, and spleen; and a lower, containing the convolutions of the small intestines. As regards the cæcum, the ascending and descending portions of the colon, they, as a general rule, are bound down by the peritoneum in their respective situations. It covers only two-thirds, or thereabouts, of their anterior surface; the rest is connected by loose cellular tissue to the back of the abdomen.*

c. Great omentum.—This broad peritoneal fold proceeds from the lower border of the stomach, like a curtain over the convolutions of the small intestines. From this resemblance its name is probably derived. In corpulent persons it is enormously loaded with fat, and contributes very much to the size of the belly. In thin subjects, on the other hand, it is often quite transparent. Its length, too, varies considerably. In some bodies we find it extending down into the pelvis; in others, quite contracted and crumpled. Now and then it is found riddled, as it were, with holes. This last state of parts is attended with some risk, for it may happen that a knuckle of intestine becomes strangulated in one of the holes; and of this, death is the almost certain result.

d. Small omentum.—This fold of peritoneum connects the stomach to the liver, and is on that account called the gastro-hepatic omentum. Its right border contains the vessels and nerves going to, and the duct coming from, the liver. If the finger be introduced beneath this border, it passes through what is called the *foramen of Winslow** into the lesser cavity of the peritoneum.

e. Gastro-splenic omentum.—This fold proceeds from the great

* It is practicable, therefore, to make an artificial anus by an incision, through the loins, into this portion of the canal. It should be remembered, however, that there are very frequent exceptions to the statement in the text. Indeed, it is by no means uncommon to find both the ascending and the descending colon completely surrounded by peritoneum, and connected in the lumbar regions, respectively, by a right and left lumbar meso-colon. There is also sometimes a meso-cæcum.

* Fatal strangulation of a portion of intestine has been known to take place in this foramen.

end of the stomach to the spleen, and is continuous below with the great omentum.

f. Course of the peritoneum.—We come next to trace the peritoneum, as a continuous membrane. To say the truth, this is not a very easy matter,—in fact, it has always been considered a sort of anatomical puzzle. Since the peritoneum is a perfect sac, it matters not where we commence our description, for after all we must come back to the point from which we started. Supposing, then, a longitudinal section were made through the viscera in the middle line of the body, one might trace the peritoneum thus—beginning at the diaphragm, and taking, for brevity's sake, two layers at a time.

From the diaphragm there proceed two layers of peritoneum to the liver, forming its lateral ligaments; they separate to enclose the liver, meet again on its under surface, and pass on, under the name of gastro-hepatic omentum, to the smaller curve of the stomach. Separating, they embrace the stomach, and meeting again at its greater curve, pass down over the small intestines to form the great omentum. At the lower margin of the great omentum they are reflected upwards (so that the omentum consists of four layers) to the spine near the pancreas, and here the layers diverge from each other. The upper layer ascends in front of the pancreas to the diaphragm; the lower layer proceeds over the arch of the colon and then back to the spine, thus forming the transverse meso-colon.* From thence it is reflected over the small intestines, forming the mesentery. From the root of the mesentery it descends into the pelvis, and invests a part of the rectum (and the uterus in the female). From the rectum it is reflected on to the posterior part of the bladder, and from thence to the wall of the abdomen, along which we trace it back to the diaphragm.

Such would be the course of the peritoneum as seen by a longitudinal section. But there are certain lateral reflections which would not be seen except by a transverse section, *e. g.* from the great end of the stomach two layers proceed to the spleen, forming

* This particular arrangement is demonstrable only in early life. As the child grows the great omentum becomes adherent to the arch of the colon.

the gastro-splenic omentum; from the transverse meso-colon it is reflected on either side over the ascending and descending colon.

g. What parts of the alimentary canal are only partially covered by peritoneum?—The descending and transverse portions of the duodenum without exception, the cæcum, the ascending and descending colon with exceptional cases, and the lower part of the rectum. These points are not without practical interest. For instance, since the descending colon is closely connected to the lumbar region by loose cellular tissue, and has not, in the majority of cases, any peritoneal covering behind it, this part of the alimentary canal is available for the purpose of making an artificial anus. The gut can be easily reached by a longitudinal incision near the outer border of the quadratus lumborum. Again, the cæcum being very liable to the accumulation of hardened fæces, is apt to engender the formation of an abscess in the cellular tissue which connects it to the right iliac fossa. The matter thus formed may either burst externally, or make its way into the bowel.*

To give another instance. The absence of peritoneum from the posterior part of the cæcum explains how a hernia may take place without a peritoneal sac. That part of the cæcum bare of peritoneum may protrude through the inguinal ring first; then, if more cæcum should come down, this is quite likely to be more or less denuded of its natural peritoneal covering, which is but very loosely connected to the gut at the sides. In this way, then, it is possible to have a very large cæcal hernia without any peritoneum before it, except just round the neck. The same thing may happen, *mutatis mutandis*, to the sigmoid flexure of the colon when it happens to be fixed in its iliac fossa like the cæcum.†

* The proposal of opening the intestinal canal, as a last resource, at some point in the abdomen, so as to evacuate its contents, and establish an artificial anus, was first made by Littre (Mém. de l'Acad. des Sciences, 1720). He proposed to open the sigmoid flexure of the colon, in a case of imperforate anus. A successful case of the kind is recorded as having been performed on a boy twenty-four hours after birth by Duset. (Recueil périod. de la Soc. de Méd. de Paris, t. iv.) The same child was reported at the age of twelve to be in good health, with an artificial anus in the left iliac fossa. (Dict. des Sciences Méd. t. xxiv.)

† The best account of iliac abscesses is to be found in the "Leçons Orales" of Duypuytren.

h Returning once more, and for the last time, to the peritoneum, anatomists sometimes speak of the lesser cavity of it, as distinguished from the greater, and they say the communication between them takes place through the foramen of Winslow. Now this lesser cavity, or sac of the omentum, is situated between the stomach and the transverse mesocolon. If, in the fœtus, air be blown into the foramen of Winslow, we distend the lesser cavity; that is, the air passes behind the stomach and then between the two down and the two up layers, so to speak, of the great omentum. As the child grows, the great omentum becomes adherent to the arch of the colon; and thus the proper sac of the omentum is closed. But the cavity behind the stomach is permanent.

23. Our next subject should be the examination of the arteries which supply the viscera. The main trunk from which they are derived, namely the aorta, enters the abdomen between the pillars of the diaphragm, and then descending in front of the spine, divides opposite the fourth lumbar vertebra into the two common iliac arteries. In this course it gives off the following branches, generally in the order here described:—

a. The *phrenic,* for the supply of the diaphragm.

b. The *cœliac axis.*—This is a short thick trunk which immediately subdivides into three branches for the supply of the stomach, the liver, and the spleen.

c. The *superior mesenteric*, for the supply of all the small intestines and the upper half of the large.

d. The *supra-renal* and the *renal* arteries.

e. The *spermatic,* for the testicles in the male, and the ovaries in the female.

f. The *inferior mesenteric,* for the supply of the lower half of the large intestine.

g. The *lumbar,* a series of branches, analogous to the intercostals, for the supply of the back part of the abdomen.

Now we shall trace these branches throughout in such order as is most convenient. Let us take the cœliac axis first. To dissect this artery and its branches the liver must be well raised, and a layer of peritoneum removed from the gastro-hepatic omentum. It will soon be discovered that there is a close network of very

tough tissue about all the visceral branches of the aorta. This tissue consists almost entirely of plexuses of nerves, derived from the sympathetic system. Of all these plexuses, the largest surrounds the cœliac axis like a ring. It is called the solar plexus,* or, more appropriately, the brain of the abdomen, for it contains a large quantity of ganglionic matter. From this, as from a root, other secondary plexuses branch off, and twine round the arteries; thus forming the phrenic plexus, the coronary, hepatic, splenic, superior mesenteric, renal, &c. It requires a very lean subject and great anatomical dexterity to trace them.

24. The *cœliac axis* arises from the front of the aorta, between the pillars of the diaphragm, just above the upper border of the pancreas. It is a very thick trunk, which, after a course of about half an inch, divides into three branches,—the coronaria ventriculi, the splenic, and the hepatic.

A. The *coronaria ventriculi,* the smallest of the three, ascends a little to the left towards the œsophageal end of the stomach, and then curves along the upper border of the stomach towards the pylorus, where it inosculates with the pyloric branch of the hepatic artery. It gives branches to the œsophagus as well as to the stomach.

B. The *hepatic* artery ascends between the layers of the lesser omentum to the transverse fissure of the liver, where it divides into branches for its several lobes. In its course to the liver, we find that it is situated on the left of the bile duct, and in front of the portal vein: all three are contained in the right border of the lesser omentum. The hepatic gives off the following:—

a. The *pyloric,* which runs along the upper curve of the stomach and inosculates with the coronaria ventriculi.

b. The *gastro-epiploica dextra.*—This runs behind the pancreas, and then along the great curve of the stomach, and inosculates directly with the gastro-epiploica sinistra, a branch of the splenic. It gives off—

1. Branches to the pancreas and duodenum (*pancreatico-duodenales*).

* This plexus is formed by the junction of the two semilunar ganglia described in the Dissection of the Thorax, § 117, *c*.

2. Branches which descend to supply the great omentum.

c. The *cystic*, a branch to the gall-bladder.

C. The *splenic*, the largest of the three, proceeds tortuously along the upper border of the pancreas to the spleen, which it enters by numerous branches. It gives off—

a. Several small branches to the pancreas, *pancreaticæ parvæ*. One, rather larger than the rest, is called *pancreatica magna*.

b. The *gastro-epiploica sinistra*.—This runs along the great curve of the stomach, and inosculates with the gastro-epiploica dextra.

c. *Vasa brevia*.—These proceed between the layers of the gastro-splenic omentum to the great end of the stomach.

Thus we perceive that the stomach is supplied with blood by four channels, which by their inosculations form a main artery along its lesser curve, and another along its greater; from these, numerous branches are furnished to both sides of the stomach. The artery of the greater curve also sends down numerous branches to the omentum, which form a beautiful network between its layers. The advantage resulting from this free inosculation of the arteries about the stomach must be at once apparent.

It has been already mentioned that in the lesser omentum we find three vessels packed up close to each other in the following relative position. The hepatic duct is on the right, the hepatic artery on the left, and the vena portæ is behind and between them. We will now give some account of the vena portæ and the duct.

25. *Vena portæ*.—The veins which return the blood from the abdominal portion of the alimentary canal, the pancreas, and the spleen, have this singular peculiarity, that they do not empty themselves into the vena cava, but all unite into one great vein, called the vena portæ, which ramifies throughout the liver, and secretes the bile. The trunk of the vena portæ itself is from three to four inches long; if we trace it downwards we find that it is formed, behind the pancreas, by the confluence of the splenic and superior mesenteric veins. On the other hand, supposing that we trace it upwards, which, however, cannot be conveniently done now, we should find that at the transverse fissure of the liver it divides into branches corresponding to the several lobes of the organ.

The vena portæ, then, may be compared to the stem of a tree, of which the roots arise in the digestive organs, and the branches spread out in the liver. Eventually all the blood from the liver returns into the vena cava through the venæ cavæ hepaticæ.

The veins which empty themselves into the vena portæ are also peculiar, in that they have no valves. Therefore, if any obstruction arise in the venous circulation through the liver, the roots of the portal vein are apt to become congested: this is a common cause of hemorrhoids, diarrhœa, hemorrhage from the bowels, and ascites. Again, leeches applied to the anus have been long recognised as beneficial in congestion of the liver.

26. *Bile duct.*—The hepatic duct is soon joined by the cystic, or the duct from the gall-bladder. The common duct, *ductus communis choledochus,* thus formed, passes along the right edge of the lesser omentum, then behind the first portion of the duodenum, and opens obliquely into the back part of the second portion. This common duct is from three to four inches long, and, if distended, would be about the size of a small writing quill.*

The superior mesenteric artery comes next under consideration. The great omentum, with the arch of the colon, must be turned up over the chest, and the small intestines should be pushed towards the left side. Then, by simply removing a layer of peritoneum from the mesentery, we expose the mode in which this great artery ramifies so as to supply the small intestines. In making this dissection, the mesenteric glands immediately attract notice. They lie in great numbers between the layers of the mesentery, and vary considerably in size. The fine tubes, called lacteal vessels, which traverse the glands, are too thin and transparent to be seen under ordinary circumstances. But in cases where sudden death has taken place during digestion, they are found distended with chyle, and can be traced into the glands from all parts of the small intestines.† After traversing the glands, they all eventually empty their contents into the receptaculum chyli.

* That the gall-duct admits of being sometimes distended to a much larger size, is proved by the passage of large gall-stones.

† The arrangement of the chyliferous vessels is extremely well displayed in the beautiful plates of Mascagni.

27. The *superior mesenteric artery* descends beneath the pancreas and over the transverse part of the duodenum, and then runs between the layers of the mesentery towards the right iliac fossa, where it terminates in branches for the supply of the cœcum. Thus its course describes a gentle curve from left to right. The left or convex side of the curve gives off a series of branches (from ten to sixteen) to the small intestines; while the concave side furnishes the right colic and the middle colic arteries for the supply of the large intestines.

a. Now we should trace the branches to the small intestines, in order to see the beautiful series of arches which they form by their mutual inosculations. There are three or four tiers of them, each tier smaller than the preceding. The ultimate branches ramify in circles round the intestine. This circular arrangement of the vessels in the coats of the bowel is practically interesting, because it enables one in almost all cases to distinguish the intestine from the hernial sac.

b. The *colic* branches of the superior mesenteric are—the right colic, which proceeds towards the ascending colon, and the middle colic, which ascends between the layers of the mesocolon to the arch. They are arranged after the same plan as those of the small intestines; that is, they inosculate so as to form a series of arches which successively decrease in size, and finally terminate in circles round the bowel.

We remember that the superior mesenteric vein joins the splenic behind the pancreas, and forms the vena portæ.

28. *Inferior mesenteric artery.*—In order to trace this artery, the small intestines must be drawn over towards the right side. It is given off about two inches above the bifurcation of the aorta. Descending into the pelvis over the left common iliac artery, it passes between the layers of the meso-rectum, and, taking the name of superior hemorrhoidal, is finally distributed to the upper part of the rectum. Its branches are—1. the *colica sinistra,* which supplies the descending colon; 2. the *sigmoidea,* which supplies the sigmoid flexure. These inosculate in the form of arches. The colica sinistra, too, forms a large arterial arch with the colica media,

so that there is a chain of arterial communications from one end to the other of the intestinal canal.

The inferior mesenteric vein joins the splenic behind the pancreas.

In order to complete our knowledge of the position of the duodenum and the pancreas, a ligature should now be placed on the upper end of the jejunum, another on the lower end of the sigmoid flexure of the colon, and the intermediate portions of the small and large intestine should be removed. By simply turning up the stomach we expose at once the horse-shoe course of the duodenum round the great end of the pancreas, and the several relations of this portion of the alimentary canal described at § 21, *a*.

29. The *pancreas* is the great salivary gland of the abdomen, and is situated immediately behind the stomach. It is of a somewhat elongated form. The larger portion, or the head, is embraced by the duodenum, and from this the gland extends across the spine to the spleen. Like all other salivary glands, it is most abundantly supplied with blood: it receives numerous branches from the splenic artery, which runs along its upper border; some from the superior mesenteric, which lies beneath it, and others, too, from the gastro-epiploica dextra. Its duct runs through it from end to end, and opens into the back part of the descending portion of the duodenum.

The liver, stomach, duodenum, pancreas, and spleen, should now be collectively removed. For this purpose it is necessary to cut through the ligaments of the liver, the venæ cavæ hepaticæ, and the branches of the cœliac axis. These viscera, as well as the remainder of the intestinal canal, should be macerated in water, while we proceed to examine all that is to be seen at the back of the abdomen; namely, the deep-seated muscles, the aorta and vena cava, the kidneys, the lumbar plexus of nerves, and the sympathetic nerve.

30. *Kidneys.*—After the removal of what remains of the peritoneum from the back of the abdomen, we discover the kidneys in the lumbar region, one on each side of the spine. They lie imbedded in more or less fat, on the quadratus lumborum and the psoas muscles, pretty nearly opposite the two lower dorsal and the

two upper lumbar vertebræ. On the top of each there is a little body, like a cocked hat, called the renal capsule. We have no difficulty in tracing the ureter, or excretory duct of the kidney. It descends almost vertically on the psoas muscle, and then, entering the pelvis generally over the division of the common iliac artery, empties itself into the lower part of the bladder.

It seems hardly necessary to repeat that in front of the right kidney, and connected to it only by cellular tissue, there is the ascending colon, and the vertical portion of the duodenum; in front of the left, the descending colon. This explains how it is that a renal abscess or a calculus is sometimes evacuated by stool.*

31. *Diaphragm.*—This is a partly muscular and partly tendinous arch, so constructed as to form a complete moveable partition between the chest and the belly—a floor for the one, and a roof for the other. We cannot see the structure of the arch until its peritoneal covering is removed. We then observe that there is a broad tendon in the centre, and that muscular fibres converge to it from all sides. Now, since the muscular fibres arise from the circumference of the chest, let us examine the particular parts to which they are attached, beginning in front, and tracing them in succession round to the spine. They arise, then, as follows:—1st. from the ensiform cartilage; 2dly. from the inside of the cartilages of the six lower ribs by as many digitations, which correspond with those of the transverse muscle of the abdomen; 3dly. in the interval between the last rib and the spine, they arise from two thin tendinous arches,† thrown, the one over the quadratus lumborum, the

* The proximity of the colon to the ureters gives us a probable explanation of the manner in which pins or other extraneous bodies sometimes find their way into the bladder, and become the nuclei of calculi. In confirmation of this, the following case is related by Velpeau, which occurred at the Hospital of La Pitié:—A pin, the head of which was still found in the colon, in which it had produced considerable ulceration, had passed also into the ureter, so that a calculus, of which the pin formed the axis, projected partly within and partly without the canal of the ureter. (Velpeau, Anat. Chir. t. ii. p. 175.)

† These arches are commonly called, respectively, the *ligamentum arcuatum internum* and *externum*. The first extends from the body of the first lumbar vertebra to its transverse process, arching over the psoas; the second extends from the same transverse process to the last rib, and arches over the

other over the psoas muscle; lastly, from the spine they arise by two elongated bundles, called the *crura* of the diaphragm. Between them the aorta enters the abdomen. We may observe that both have tendinous origins, but that the right crus is a little longer than the left; for it arises from the bodies of the three or four upper lumbar vertebræ and their intervening cartilages, whereas the left does not descend so low by one vertebra.

Proceeding from these various sources, the fibres ascend at first nearly vertically, and then all arch inwards, and are inserted into the central tendon.

a. The *central tendon* is nearly the highest part of the diaphragm. It presents a beautiful glistening surface, owing to the various directions in which its fibres cross each other; and its shape may be rudely compared to that of a trefoil leaf. The chief point of interest about the tendon is, that, in consequence of its connections in the chest, it is always maintained pretty nearly on the same level; so that it both supports the heart, and serves as a fixed point for the insertion of the muscular fibres of the diaphragm.

There are three openings in the diaphragm for the transmission of the aorta, the œsophagus, and the vena cava respectively. The aortic opening is, as before observed, between the crura, close to the spine; it transmits, also, the vena azygos and the thoracic duct, both of which lie rather to the right of the aorta. Now, if the crura be traced upwards, it may be observed that the inner fibres of each cross each other in front of the aorta, somewhat like the letter X.* Just above the crossing, and a little towards the left side of it, we find the œsophageal opening; this is entirely muscular, whereas the aortic is partly tendinous. The opening for the vena cava is situated in the central tendon, rather to the right of the middle line; and we observe that the vein is intimately con-

quadratus lumborum; in point of fact they are nothing more than the upper borders of the sheaths of these muscles, specially thickened for the purpose of giving origin to the fibres of the diaphragm. Where else could the fibres take origin in this situation?

* This decussation is not invariable. But the right crus always crosses more or less over the left, so that the crura are never strictly parallel.

nected to its margin, so that it may be kept permanently open. Lastly, there pass through the crus, on each side, the sympathetic, and the greater and lesser splanchnic nerves.

Function of the diaphragm.—The diaphragm is the chief muscle concerned in respiration. Next to the heart, therefore, it is the most important muscle in the body: "musculus post cor nobilissimus."* During inspiration, the diaphragm contracts and becomes less arched; the floor of the chest sinks in consequence, and more room is made for the expansion of the lungs. During expiration the diaphragm relaxes, and is forced up to its former position by the pressure of the abdominal muscles on the viscera. This alternate sinking and raising of the diaphragm constitutes the mechanical part of the breathing. But the diaphragm conduces to the production of many other functions. Acting in concert with the abdominal muscles, it compresses the viscera and assists in the expulsion of the fæces and the urine, also in parturition and in vomiting. Moreover, it is one of the chief agents concerned in laughing, sneezing, coughing, hiccough, &c.

32. *Psoas magnus.*—We must now raise one of the kidneys from its bed, in order to examine a long muscle, called the psoas, which extends from the sides of the lumbar vertebræ into the thigh. In dissecting this muscle we are to take care, 1st. of the sheath in which it is contained; 2dly. of the branches of the lumbar plexus, which emerge from it; and 3dly. of the sympathetic nerve, which runs down the spine close and nearly parallel to its inner border.

Respecting the sheath of the psoas, we have to notice its attachment to the sides of the vertebræ and the brim of the pelvis. It is this which determines the ordinary course of a psoas abscess, namely, beneath the crural arch into the upper part of the thigh; for it is a rare exception when the matter travels into the pelvis.

The psoas arises from the bodies and transverse processes of the lumbar vertebræ, and their intervening fibro-cartilages; but, observe, only from the projecting borders of the vertebræ, not from the central grooved part: here the fibres arise from a kind of

* Haller.

tendinous arch thrown over the lumbar vessels. The muscle descends beneath the crural arch into the thigh, and is inserted by a strong tendon into the lesser trochanter of the femur.

As it passes under the crural arch, the tendon of the psoas lies immediately over the capsule of the hip joint, and there is a large bursa between them to facilitate the play of the tendon. We ought to be aware that every now and then, even in young subjects, but more frequently in old ones, as a consequence of wear and tear, this bursa communicates with the capsule of the hip joint. The fact is interesting for many reasons: to mention one only, it explains how it happens that a psoas abscess sometimes makes its way into the hip joint.

a. Once in about eight or ten subjects we meet with a little muscle called the *psoas parvus.* It arises from the last dorsal and the first lumbar vertebra, and the intervening cartilage; then descending in front of the great psoas, it soon ends in a long flat tendon, which gradually spreads out, and is inserted into the brim of the pelvis.

33. *Iliacus internus.*—This muscle occupies the iliac fossa, and is covered by a fascia, which first claims attention. This *iliac fascia,* as it is called, is attached to the crest of the ilium, and indirectly to the brim of the pelvis through its connection with the sheath of the psoas. But its most important attachment is to the outer half of the crural arch; here it is directly continuous with the fascia transversalis, so that together they present an effectual barrier to the escape of intestine beneath this part of the arch.*

To return to the muscle. It arises from the iliac fossa, from the ilio-lumbar ligament,† and also from the capsule of the hip

* The iliac fossæ are very liable to be the seat of suppuration, and the course which the matter takes depends upon its position with regard to the iliac fascia. If the matter be seated in the loose cellular tissue between the peritoneum and the fascia, it usually advances towards the groin through the inguinal canal; but, if seated beneath the fascia, the chances are much in favour of the matter making its way under the crural arch, towards the upper and outer part of the thigh.

† This ligament extends from the transverse process of the last lumbar vertebra to the ilium.

joint. The fibres pass through an especial groove in the bone beneath the crural arch, and are inserted into the tendon of the psoas. Thus the two muscles, so far as their action goes, may be considered as one.

The combined *action* of the psoas and iliacus is to assist in raising the body from the recumbent position, and to fix the pelvis steadily on the thigh: this supposes the fixed point to be at the trochanter. But supposing the fixed point to be at the spine, then the muscle can bend and rotate the thigh outwards. It is this action which is so troublesome to counteract in fractures of the upper third of the femur.

34. *Quadratus lumborum.*—This muscle extends from the crest of the ilium to the last rib, and is contained in a sheath formed for it by the aponeurotic origin of the tranversalis. The anterior layer of its sheath is attached to the roots of the transverse processes of the lumbar vertebræ, and the posterior layer to their summits. The muscle arises from about an inch and a half of the crest of the ilium and from the ilio-lumbar ligament: it ascends nearly perpendicularly, and is inserted into the last rib, and into the front of the transverse processes of the four upper lumbar vertebræ by as many tendinous slips. In addition to these, however, we commonly find that a few fibres take origin from the transverse processes, and run up to the last rib, crossing the front of the other part of the muscle. The principal use of the muscle is to steady the last rib, and to enable it to serve as a fixed point for the action of other muscles.*

By partially raising the quadratus, we observe the aponeurotic origin of the transversalis from the summits of the transverse processes: this constitutes the posterior part of its sheath, and separates the muscle from the great erector spinæ.

Previous to the description of the course of the aorta and its great primary divisions, we must not omit to notice that a chain of absorbent glands extends along the brim of the pelvis and the

* The respective attachments of the quadratus lumborum, the crossing of its fibres, and its mode of action, lead to the inference that it is a large intercostal muscle.

bodies of the lumbar vertebræ, following pretty nearly the course of these great blood-vessels. Generally speaking, they are on the average small, and only one here and there attracts observation. They transmit the lymphatics from the lower limbs, the abdominal wall, and the testicle, and all eventually lead to the *receptaculum chyli,* or the beginning of the thoracic duct.* This is usually found on the right of the aorta, close to the second lumbar vertebra.

35. RELATIONS OF THE ABDOMINAL AORTA.—The aorta enters the abdomen between the crura of the diaphragm, and descends nearly perpendicularly in front of the spine as low as the fourth lumbar vertebra, where it divides, rather to the left of the mesial line, into the two common iliac arteries. The point of division cannot be specified with precision, because it is so apt to vary in different subjects, being often lower and sometimes higher than the fourth lumbar vertebra. But for all practical purposes it is sufficient to know that its division takes place about the level of the highest point of the crest of the ilium. The vena cava inferior ascends on the right of the aorta, close to the spine also, in the greater part of its course. As it approaches the diaphragm, however, the vena cava must necessarily pass off a little to the right, in order to go through its appropriate tendinous opening in the diaphragm, and so reach the right side of the heart.

The branches of the aorta left for us now to examine arise from it in pairs, namely—

a. The phrenic.—These arteries are intended for the supply of the diaphragm, and generally proceed from the aorta as soon as it comes through the pillars. But this particular origin is by no means invariable. The right phrenic passes behind the vena cava, the left behind the œsophagus, and both ramify extensively on the corresponding sides of the muscle. Their first branches, however, are sent to the renal capsules. Their ultimate ramifications extend to the circumference of the chest, and inosculate with the internal mammary and intercostal arteries. The phrenic *veins* are the last which the inferor vena cava receives.

* See the Dissection of the Thorax, § 114.

b. The *capsular* arteries proceed to the renal capsules.

c. The *renal* arteries come from the aorta at right angles, and run transversely to the kidneys. Both are covered by their corresponding veins. The right is necessarily longer than the left, and crosses beneath the vena cava. Each enters its kidney, not as one trunk, but by several branches, corresponding to the original lobes of the organ. The renal veins, as before said, lie in front of the arteries, and join the vena cava at right angles. The left is longer than the right, and has to cross over the aorta; it receives the spermatic vein of its own side, which the right does not. These trifling differences, it will at once be perceived, are necessarily owing to the respective position of the aorta and vena cava.

d. The *spermatic* arteries arise from the front of the aorta a little below the renal. They descend along the psoas muscle, and then through the inguinal canal to the testicle. In the fœtus, of course, they are much shorter, but they gradually lengthen as the testicles leave the abdomen. In the female, the corresponding arteries proceed between the layers of the broad ligament to the ovaries. Each artery is accompanied by two very tortuous veins, which unite and then empty themselves, on the right side, into the vena cava; on the left, into the renal vein.

e. Lumbar arteries.—These arise from the back of the aorta, and are five in number on either side. They are strictly repetitions of the intercostal arteries on a small scale, so that "lumbar intercostals" would be an appropriate name for them. They proceed outwards over the centres of the vertebræ towards the intervertebral foramina, and then, like the thoracic intercostals, divide into dorsal and abdominal branches.

1. The *dorsal* branches pass between the transverse processes to the muscles of the back, and are of a size proportionate to the large development of these muscles. They also send arteries into the spinal canal.

2. The *abdominal* branches run outwards behind the quadratus lumborum, all except the first and the last, which commonly run in front. After supplying the quadratus and psoas, they are lost in the wall of the abdomen.*

* Just as the thoracic intercostals, by communicating with the internal

The lumbar *veins* empty themselves into the vena cava.

36. Common iliac arteries.—The two common iliac arteries diverge from each other at an acute angle, towards the sacro-iliac symphysis, and after a course of about two inches, more or less, divide into the external and internal iliac. They lie close to the vertebræ, and each, at or near its point of division, is crossed by the ureter: the left one is also crossed by the colon. But the most important relation of these arteries, in a practical point of view, respects their position with regard to their great veins. In consequence of the vena cava lying on the right of the aorta, we see, at a single glance, that the right common iliac artery crosses over both the common iliac veins previous to their confluence. It is also very closely connected to them. For these reasons it is much easier to pass a ligature round the left artery than the right; for though its vein lie on its inner side, yet it is sufficiently far off to be out of the way of danger. With the parts now before him the learner would do well to consider what would be the easiest way of performing such an operation, of course without wounding the peritoneum. Several modes have been recommended. Upon the whole, the best authorities* agree that the artery is most accessible from behind. An incision should be made perpendicularly from about the free end of the last rib to the ilium, and another transversely along the margin of this bone nearly to its spine. We then cut, layer after layer, through the abdominal muscles till the peritoneum is exposed; this is easily raised from the iliac fascia, and with it the ureter is raised too. The application of the ligature is, after all, the most delicate part of the operation. It ought to be placed, as near as possible, midway between the origin and the division of the artery, so that there may be room enough for the formation of a clot on either side.†

mammary, form a vascular ring round the chest, so do the lumbar, by communicating with the epigastric, form a vascular ring, though a less perfect one, round the walls of the abdomen.

* Consult some observations in point by Sir P. Crampton, in Med.-Chir. Trans. vol. xvi.

† It is important to be aware that the length of the common iliac artery

37. External iliac artery.—This artery passes along the brim of the pelvis, on the inner side of the psoas, and then running under the crural arch about midway between the spine of the ilium and the symphysis pubis, takes the name of femoral. The corresponding vein lies close to its inner side. After the removal of the peritoneum, we ought to notice that these vessels are not quite bare, but that they are covered by a thin layer of fascia which binds them down to the psoas. There are only two other circumstances of practical interest respecting this artery; 1st. a slender nerve, called the genito-crural, runs close and nearly parallel to its outer side; 2dly. just before it leaves the pelvis it is crossed by the circumflexa ilii vein, one of tolerably large size. The branches given off by this artery are—

a. The *epigastric,* already described (§ 12).

b. The *circumflexa ilii.*—This artery arises just above the crural arch, and then runs towards the spine of the ilium in a sheath formed for it by the fascia iliaca.* In the dissection of the abdominal muscles, we saw the continuation of it skirting the crest of the ilium between the internal oblique and the transversalis, and sending a branch upwards between these muscles for their supply. The main trunk, much reduced in size, inosculates with the ilio-lumbar derived from the internal iliac.

The easiest way of tying the external iliac would be to make an incision at the lower part of the belly, beginning a little above the middle of the crural arch, and ending a little beyond the spine of the ilium. The strata of the abdominal muscles, with the fascia

is very apt to vary in different persons. We have seen it from three-fourths of an inch to three and half inches long. These varieties may arise either from a high division of the aorta, or a low division of the common iliac, or both. It is impossible to ascertain, beforehand, what will be its length in a given instance, for there is no necessary relation between its length and the height of the adult individual. It is often very short in men of tall stature, and vice versâ. Anatomists generally describe the left as rather longer than the right: but, from the examination of 100 bodies, we conclude that their average length is the same.

* The course of this artery should be borne in mind in opening iliac abscesses.

transversalis, should then be divided to the same extent; after which, the peritoneum can be readily raised by the finger from the iliac fossa. It would be necessary to make a small incision through the sheath of the vessel, in order to facilitate the passage of the needle. We remember that the vein is closely connected to its inner side,* and that the genito-crural nerve is not far off.

We have now briefly to direct attention to the sympathetic nerve and the lumbar plexus of nerves.

38. Sympathetic nerve.—Respecting the general plan upon which the sympathetic nerve is arranged, we must refer to what has already been said of it in the dissection of the neck (§ 92). Our present business is with the lumbar portion of it.

The abdominal part of the sympathetic nerve descends, on either side, in front of the bodies of the lumbar vertebræ, along the inner border of the psoas. The nerve has a ganglion opposite each lumbar vertebra, so that there are five on each side. Each of these ganglia receives two branches from the corresponding spinal nerve, just as in the chest; and, on the other hand, gives off filaments, of which some twine round the aorta, and accompany the inferior mesenteric and spermatic vessels to the large intestine and

* This relative position of the vessels must not always be taken for granted. In old subjects, less frequently in adults, it is sometimes found that the external iliac artery runs very tortuously instead of nearly straight along the brim of the pelvis. But the vein does not follow the artery in its windings, and may possibly lie outside the artery just where we propose to place the ligature.

The mode of performing the operation described in the text is recommended by Sir A. Cooper. Mr. Abernethy, however, who first set the example of tying this artery in 1796, adopted a somewhat different proceeding. He says: "I first made an incision about three inches in length through the integuments of the abdomen, in the direction of the artery, and thus laid bare the aponeurosis of the external oblique muscle, which I next divided from its connection with Poupart's ligament, in the direction of the external wound, for the extent of about two inches. The margins of the internal oblique and transversalis muscles being thus exposed, I introduced my finger beneath them for the protection of the peritoneum, and then divided them. Next, with my hand, I pushed the peritoneum and its contents upwards and inwards, and took hold of the artery."

the testicle respectively; but the greater number terminate in the hypogastric plexus.

a. The *hypogastric plexus* is situated between the common iliac arteries on the last lumbar and first sacral vertebra. It consists of an inextricable interlacement of nerves, partly sympathetic and partly spinal, and is a sort of nerve-centre for the supply of the pelvic viscera, like the solar plexus (round the cœliac axis) is for the abdominal. The minute filaments proceeding from it accompany the visceral branches of the internal iliac artery, and supply the bladder, prostate gland, rectum, and, in the female, the uterus and vagina. Thus we have the vesical, hemorrhoidal, uterine, and vaginal plexuses. Of these, however, none are seen in an ordinary dissection.

39. LUMBAR PLEXUS OF NERVES.—This plexus is formed by the union of the four upper lumbar nerves. It lies over the transverse processes of the corresponding vertebræ, imbedded in the substance of the psoas, so that this muscle must be scraped away before it can be seen. Like the brachial plexus, the nerves composing it successively increase in size from above. Its branches are five in number, and generally arise in the following order:—

a. The *first lumbar* nerve is, both in course and distribution, analogous to an intercostal nerve, and may, therefore, be appropriately called the *lumbar intercostal*.* It crosses obliquely over the quadratus lumborum to the crest of the ilium, and then, entering the abdominal wall, proceeds round to the front and terminates in the skin of the hypogastrium. Like the other intercostals, it gives off a lateral cutaneous branch; but this is of much larger size than the others, and runs over the crest of the ilium to supply the skin of the buttock.

b. The *external cutaneous nerve of the thigh* is generally derived from the second lumbar nerve. It runs through the psoas, then, crossing obliquely the iliacus towards the spine of the ilium,

* It often happens that the first lumbar nerve divides into two branches: of these, the upper is generally termed the ilio-hypogastric; the lower, the ilio-inguinal. But both run nearly a similar course, and have a similar distribution.

passes beneath the crural arch, and is finally distributed to the skin on the outside of the thigh.

c. The *genito-crural nerve* is but of small size, and generally comes from the second lumbar. After perforating the psoas, it descends along the outer side of the external iliac artery, and near the crural arch divides into the *genital* branch, which runs through the inguinal canal, and is lost in the cremaster muscle,—and the *crural,* which proceeds under the crural arch, and is lost in the skin of the upper part of the thigh.

d. The *anterior crural* is the largest and most important branch of the plexus, and is generally formed by the union of the third and fourth lumbar nerves. It descends in a groove between the psoas and the iliacus, supplies both these muscles, and then, passing under the crural arch, is finally distributed to the extensor muscles and the skin of the thigh.

c. The *obturator nerve.* — This is also of considerable size, though less than the preceding. It proceeds from the third and fourth lumbar nerves, descends rather below the brim of the pelvis to the obturator foramen, and is finally distributed to the adductor muscles of the thigh.

Postponing, for the present, the minute anatomy of the abdominal viscera, let us begin the examination of the contents of the pelvis.

DISSECTION OF THE PELVIS.

40. We would first remind the reader of the general purposes served by the pelvis, and, what is of still more practical importance, the direction of its axis.

Now the general purpose of the pelvis is to protect its own viscera, and to support those of the abdomen ; to give attachment to the several muscles which steady the trunk ; and to transmit the weight of the trunk to the lower limbs in such a manner that, though they support the body, yet they can freely move. In adaptation to these purposes, the form of the pelvis is that of a perfect arch, with broadly expanded wings at the sides, and projections in

appropriate situations in order to increase the leverage of the muscles. The sacrum, impacted as it is between the ilia, represents the key-stone of the arch, and is capable of supporting not only the trunk, but great burdens besides. The sides or pillars are represented by the ilia; these transmit the weight to the heads of the thigh bones, and are thickest and strongest just in that line, *i. e.* the brim of the pelvis, along which the weight is transmitted. Moreover, to effect the more direct transmission of the weight, the plane of the arch is remarkably oblique. This obliquity of the pelvis, its hollow expanded sides, its great width, the position and strength of the tuberosities of the ischia, are so many proofs that man is adapted to the erect posture.

The general conformation of the pelvis in the female is somewhat modified, so as to be better adapted to utero-gestation and parturition. Its breadth and capacity are greater than in the male, though its depth is less. The alæ of the iliac bones are more expanded. The projection of the sacrum is less perceptible, and consequently the brim is more circular. Above all, the span of the pubic arch is wider. The bones, too, are thinner, and the muscular impressions less strongly marked.

The cavity of the pelvis being curved, the axis, or a central line drawn through it, must be curved in proportion. For all practical purposes, it is sufficient to remember that the axis of the cavity corresponds with the curve of the sacrum. Therefore, the axis of the brim—that is, a line drawn at right angles to its plane—would coincide with a line drawn from the umbilicus to the lower part of the sacrum; the axis of the outlet looks downwards and forwards, and forms, with that of the brim, about a right angle.*

41. *Contents of the male pelvis.*—The male pelvis contains the last part of the intestinal canal (misnamed the rectum), the bladder

* In a well-formed female, the base of the sacrum is about four inches higher than the upper part of the symphysis pubis; and the point of the coccyx is rather more than half an inch higher than the lower part of the symphysis.

The obliquity of the pelvis is greatest in early life. In the fœtus, and in young children, its capacity is small; and the viscera, which subsequently belong to it, are situated in the abdomen.

with its prostate gland at the neck, and the vesiculæ seminales. If the bladder be empty, there will be also part of the small intestines in the pelvis; but not so if the bladder be distended.

It is quite clear that we cannot thoroughly understand the anatomy of the pelvic viscera without making a side view of them. At the same time there are one or two matters concerning them which can be more satisfactorily investigated while the pelvis is undisturbed; and to these, therefore, our attention will now be directed.

a. On looking down from the abdomen into the pelvis, we observe that the rectum enters it usually on the left side of the sacrum, and that, after describing a curve corresponding with the concavity of the sacrum, it terminates at the anus. We observe, too, that, in the first part of its course, it is loosely connected to the back of the pelvis by a peritoneal fold, called the "meso-rectum;" and that between the layers of this fold the terminal branches (commonly called the superior hemorrhoidal) of the inferior mesenteric vessels, with the accompanying nerves and absorbents, proceed and ramify round the bowel. But it is very important to remember that the rectum does not take the above course in all cases. We sometimes find that it makes one, or even two, lateral curves; or that it enters the pelvis on the right side instead of the left. Since these variations from the usual arrangement cannot be ascertained during life, they should make us cautious in the introduction of bougies; for such things have happened as a perforation of the intestine.*

b. Whilst the parts are still undisturbed, we should introduce the fingers into what is called the *recto-vesical peritoneal pouch.* This is a kind of cul-de-sac formed by the peritoneum in passing from the front of the rectum to the lower and back part of the bladder. Now, in the adult male subject, the bottom of this pouch is about three-fourths of an inch distant from the prostate gland:†

* In old age the rectum has sometimes a zig-zag appearance immediately above the anus. These lateral inclinations are probably produced by the enormous distensions to which the bowel has been occasionally subjected.

† The bottom of the pouch is from three and a half to four inches distant

therefore there is a part of the under surface of the bladder not covered by peritoneum; and since this part is in immediate contact with the rectum, it is quite practicable to tap the distended bladder through the front of the bowel. The operation is occasionally performed by some surgeons of good repute, and with great success. It is easily done, and not attended with much risk, provided all the parts be in their regular position. But this is not always the case. It sometimes happens that the peritoneal pouch comes down lower—that is, nearer to the prostate than usual—or it may actually touch the gland; so that in such a case it would be next to impossible to tap the bladder from the rectum without going through the peritoneum. Here it may be as well to mention, that in young children the peritoneum comes down as low as what little prostate there is at this period of life; and this, for the reason that the bladder is in great part in the abdomen.

c. The recto-vesical pouch is permanent. But there is another peritoneal pouch on the front part of the bladder, which is only produced when the organ is distended. Let us, therefore, blow up the bladder through one of the ureters. It soon fills the pelvis, and then, rising into the abdomen, occasions the pouch in question between it and the abdominal wall. At first the pouch is shallow, but it gradually deepens as the bladder rises. Now, supposing that the bladder be distended half way up to the umbilicus, which is commonly the case when it has to be tapped, we should find that the bottom of the pouch would be about two inches from the symphysis pubis. Within this distance from the symphysis the bladder may be tapped in the linea alba, without risk of wounding the peritoneum; so that, when such an operation becomes necessary, the surgeon has the choice of two situations in which it may be performed,—above the pubes, or from the rectum. Which of the two be the more appropriate must be decided by the circumstances of the case.

from the anus. Being the lowest part of the peritoneal sac, it might be chosen as a fitting place for tapping in ascites.

THE DISSECTION OF THE MALE PERINEUM.

42. It is advisable to examine first the osseous and ligamentous boundaries of the lower aperture of the pelvis. Looking at a male pelvis (with the ligaments preserved), we observe that this aperture is bounded in front by the pubic arch, and behind by the coccyx and the great sacro-ischiatic ligaments.

This space may, for convenience of description, be divided into two, by an imaginary line drawn from one tuber ischii to the other. The anterior forms a nearly equilateral triangle, of which the sides are from three to three and a half inches in length; and since it transmits the urethra, we may call it the urethral division of the perineum. The posterior, containing the anus, may be called the anal division.*

The subject is supposed to be placed in the usual position for lithotomy, with a full-sized staff in the bladder, and the rectum artificially distended. We observe that a central ridge, named the *raphé*, extends from the anus along the perineum, the scrotum, and the under surface of the penis. It may not be out of place, before the parts are disturbed, to mention that in the lateral operation of lithotomy the incision should commence on the left side of the raphé, rather more than an inch in front of the anus, and that it should be carried obliquely downwards to a point about midway between the anus and the tuber ischii. In the bilateral operation the incision is semilunar, the horns being made on either side between the tuber ischii and the anus, equidistant from these points respectively; while the centre of the incision runs about three-quarters of an inch above the anus.

At the anus it is observable that the skin becomes finer and more delicate, forming a gradual transition towards mucous membrane; and during life it is drawn into wrinkles by the permanent contraction of the cutaneous sphincter. Moreover, the skin at the

* It is well to bear in mind that the dimensions of the lower outlet of the pelvis are apt to vary in different subjects, and the lithotomist must modify his incisions accordingly.

margin of the anus is richly provided with minute glands,* which secrete an unctuous substance to facilitate the passage of the fæces. When this secretion becomes defective or vitiated, the anal cutaneous folds are apt at the same time to become excoriated, chapped, or fissured; and then defæcation becomes exceedingly painful.

43. *Superficial fascia.*—It matters little how we reflect the integument. A convenient way is to make an incision down the raphé, around the anus, and so back to the coccyx. Two others may then be made on each side at right angles to the first, the one at the upper, the other at the lower end of it. Thus the skin of the perineum may be turned back like folding doors. In reflecting the skin, we have to notice the common subcutaneous adipose and cellular structure. It need scarcely be alluded to here, since it has been so frequently mentioned elsewhere that this tissue varies in thickness according to the general condition of the body.† It is observable, however, that its characters alter in exact adaptation to the exigencies of each particular part. For instance, on and near the scrotum the fat constituent of the tissue is entirely and for obvious reasons absent, while the fibro-cellular element is most abundant, and during life elastic and contractile. But, as we recede from the scrotum and approach the anus, the fat accumulates more and more, and on either side of the rectum it is found in the shape of large pellets, filling up what would otherwise be two deep hollows in this situation, namely the ischio-rectal fossæ. The purpose of this accumulation of fat on each side of the anus must be apparent; it permits the easy distension and contraction of the lower end of the bowel during and after the passage of the

* These glands are the analogues of the anal glands in some animals, *e. g.* the dog and the beaver. They are found not only about the anus, but also in the subcutaneous tissue of the perineum—a fact for the demonstration of which we are indebted to Mr. Quekett. They are large enough to be seen with the naked eye.

† The probable thickness of this subcutaneous tissue is a point which ought to be determined by the lithotomist in making his first incision. Its great thickness in some cases explains the depth to which the surgeon has to cut in letting out matter from the perineum.

fæces.* Again, over the tuberosities of the ischia we meet with large masses of fat, separated by strong fibrous septa passing from the skin to the bone, so as to constitute a sort of elastic padding to sit upon. Occasionally, too, there are one or more large bursæ interposed between this padding and the bone.

So much respecting the general characters of the superficial perineal fascia, as it is called : and now for one other point about it of practical interest. Some anatomists describe this fascia as consisting of three, four, or even more layers, but in nature we do not find it so. We may, indeed, divide it into as many layers as we please, according to our skill in dissecting; but that only complicates what is, in itself, simple. All that requires notice is that the deeper stratum contains less fat, and has, therefore, more of a membranous appearance than the superficial one, and that it is attached on either side to the rami of the pubes and ischium. This explains why urine, blood, or pus effused into the perineum does not make its way on to the thighs, but travels up into the scrotum and penis, where there is no resistance, and so progresses over the surface of the abdomen.

Having thus directed attention to the subcutaneous tissue, we have next to examine the cutaneous sphincter muscle of the anus, and the superficial vessels and nerves of the perineum.

44. The *cutaneous sphincter* of the anus arises from the point of the coccyx, and from the ano-coccygeal ligament. The muscular fibres surround the anus, and are lost in a pointed manner in the tendinous centre of the perineum. It is called the cutaneous sphincter to distinguish it from a deeper and much more powerful band of muscular fibres which surrounds the last inch or more of the rectum, and is situated close to the mucous membrane.

45. *Cutaneous vessels and nerves.*—The cutaneous vessels and nerves of the perineum are derived from the internal pudic artery and nerve respectively, and chiefly from that branch of it which

* It is this fat in the ischio-rectal fossæ which renders them so liable to the occurrence of peculiarly fœtid gangrenous abscesses. These should be opened as early as possible lest they burst into the rectum; and one sees how deep the knife must be introduced in order to reach the seat of the mischief.

is appropriately called the *superficialis perinei.* This we shall have occasion to trace more fully presently. There is, however, a cutaneous nerve sent to these parts from the lesser ischiatic, called the *long pudendal nerve.* It comes through the muscular fascia of the thigh a little above the tuber ischii, and ascends, dividing into filaments, which supply the skin of the perineum and scrotum.

a. In removing the fat from the ischio-rectal fossa, we observe that a number of vessels and nerves run through it in a transverse direction from the ramus of the ischium towards the anus. These are the *external* or *inferior hemorrhoidal,* and proceed from the great pudic trunk, which may be felt on the inner side of the ischium. They are irregular in their number and size, but scarcely ever so large as to occasion serious hemorrhage, when any of them happen to be divided either in lithotomy or in laying open a fistula.

46. *Muscular fascia.*—Supposing the subcutaneous structure to be fairly cleared off, we come upon the proper fascia which invests the muscles of the perineum, and is, in every sense, analogous to muscular fascia in other parts, for it not only covers the muscles collectively, but provides each with a distinct sheath. At the same time it is much less dense, though more elastic, than the strong fascia,—say, for instance, of the limbs; and there is, indeed, so much resemblance between it and what we have described as the deeper stratum of the subcutaneous tissue, that the learner will hardly recognize any distinct plane of demarcation between them. Such, however, as it is, what are its connexions? 1. It is attached on either side to the rami of the pubes and ischium; 2. if traced forwards, it will be found to be directly continuous with the *tunica dartos* of the scrotum; 3. if traced backwards, we find it runs into the fascia lining the ischio-rectal fossa; 4. along a transverse line about the level of the front of the anus, it recedes from the surface, and becomes intimately connected with the deep perineal fascia. Along the line indicated, it forms a partition between the urethral and anal divisions of the perineum. This is the reason why, when urine is effused into the perineum, it cannot make its way into the ischio-rectal fossa.

Let us now remove the fascia in order to examine the muscles

which cover the bulb of the urethra and the crura of the penis. The bulb of the urethra lies in the middle line of the perineum, and is covered by a strong muscle, called the accelerator urinæ. The crura penis are attached, one to each side of the pubic arch, and are covered each by a muscle called the erector penis. Very commonly, a narrow slip of muscle, called the transversus perinei, extends on either side from the tuber ischii to the *central tendinous point* of the perineum. This point is about equidistant from the anus and the bulb of the urethra, and serves for the fixation of muscular fibres from all quarters of the perineum.

If the direction of the preceding muscles be clearly understood, it will be observed that they describe on each side a triangle, of which the sides are formed by the accelerator urinæ and the crus penis respectively, and the base by the transversus perinei. Across this triangle there run up from base to apex the superficial perineal vessels and nerves. These we must notice before the description of the muscles.

47. *Superficial perineal vessels and nerves.*—The superficial perineal artery proceeds from the main pudic trunk as it runs up the inner side of the pubic arch; and, though we cannot see the trunk, we can easily feel it by pressing the finger against the bone. The artery comes into view a little above the level of the anus, and then passes up the perineal triangle, distributing numerous cutaneous branches in its course, and is finally lost on the scrotum. But its largest branch is a muscular one, called the *transversalis perinei.* This is given off near the base of the triangle, and runs towards the central point of the perineum. It is necessarily divided in the first incision in lithotomy, and deserves attention, because it is sometimes of considerable size.

The artery is accompanied by two veins, which are frequently dilated and tortuous, especially in diseased conditions of the scrotum.

Respecting the nerves, it need only be mentioned that they are derived from the internal pudic, follow the course of their corresponding arteries, and give off similar branches. They not only supply the skin of the perineum and scrotum, but each of the perineal muscles.

48. Muscles of the Perineum.—*Accelerator urinæ.* This muscle embraces the bulb of the urethra. To simplify the description of it, let us consider it as arising from a sort of fibrous median seam or raphé beneath the bulb, and from the tendinous centre of the perineum. Starting from this origin, the fibres diverge and are inserted as follows:—The anterior proceed on either side round the corpus cavernosum penis, like the branches of the letter V, and are fixed on its upper surface: the succeeding fibres completely embrace the bulb, like a ring, and meet in a tendon on the upper surface of the urethra; while the lower fibres are fixed on either side upon the deep perineal fascia, and perhaps a few upon the crus penis. Thus, then, the entire muscle acts as a powerful compressor of the bulb, and expels with violence the last drops of urine from this part of the urethra. By dividing the muscle along the middle line, and turning back one or other half, we can clearly make out its insertion as above described.

a. Erectores penis.—These muscles are moulded, as it were, one upon each crus of the penis. Each muscle arises from the inner surface of the tuber ischii, and from the extremity of the great sacro-ischiatic ligament; the fibres ascend, completely covering the crus, and terminate on a strong aponeurosis, which is gradually lost on the corpus cavernosum penis. The *action* of these muscles is to compress the root of the penis, and so to contribute in some way to the erection of the organ.

b. Transversi perinei.—These muscles are always of insignificant size. They arise one on each side from the tuber ischii, and proceed inwards towards the central point of the perineum, where they are generally blended with the fibres of the accelerator urinæ. But they differ much in different subjects, are not always alike on both sides, and indeed are often absent.

49. A word or two must now be said respecting the space between the anus and the ischium, called the *ischio-rectal fossa.* If all the fat be removed from the cavity, we notice that it is lined on all sides by fascia. In order to form a correct idea of its extent, the learner should examine it with his finger. Its area may be described as more or less triangular, with the apex deep in the pelvis, and the base below. The outer boundary is the ramus of

the ischium with the obturator internus muscle; the inner boundary is the rectum and the levator ani; posteriorly it is overlapped by the glutæus maximus. The external hemorrhoidal vessels and nerves which cross the space have been already alluded to.

An inspection of these deep recesses on either side of the rectum explains the great size which abscesses in this situation may attain, and also the difficulty of curing them when of long standing; for the boundaries of the recess are of such a nature that we cannot maintain them in permanent apposition. There is the constantly varying size of the rectum on the one hand, and the immoveable wall of the pelvis on the other. These facts should impress upon us the necessity of making a free opening into these abscesses at an early stage, before they have formed a large cavity, denuded the rectum, and possibly made way into it by ulceration.

50. Structures surrounding the urethra in its passage through the pubic arch.—Returning to the urethral triangle, let us next examine the deepest stratum of the perineum, or what may be appropriately called its floor. This, in every point of view, is the most important part of our subject, since it comprises the anatomy of the structures which surround the urethra in its passage beneath the pubic arch. It need scarcely be said that this part of the urethra demands special attention; for here the incision is made in lithotomy, here is the most frequent seat of stricture, &c. Notwithstanding its practical interest, the anatomy of this part is seldom thoroughly understood, because it is a kind of neutral ground between the perineum and the pelvis, and because authors differ in their description of it.

To make the matter as intelligible as possible, we will first give a brief sketch of the general plan upon which this stratum is constructed, and then examine separately its constituent parts.

First, then, as to what may be called the *groundwork* of the stratum itself. Supposing that the cura penis, with their respective muscles, be raised from their attachment to the bone,—and this, by the way, requires an experienced hand,—we then observe that the pubic arch is blocked up by a plane of muscular fibres passing from one side of the arch to the other. This muscular plane is covered by a fascia, called the deep perineal, which not only gives strength

to the plane, but also affords surface for the origin of its muscular fibres. About one inch below the symphysis pubis the plane is traversed by the urethra; in the substance of it there runs on either side the large artery which supplies the bulb; and there are also, on either side of the bulb, Cowper's glands.

Now, this muscular plane, though apparently consisting of a single muscle, is, in point of fact, made up of three: herein lies the difficulty, a difficulty not inherent in the subject itself, but because we have not a view of the parts from their pelvic side.

What, then, are the three muscles? As follows:—a little above the anus there are the anterior fibres of the levator ani; higher up, that is behind the bulb, there is the transversus perinei profundus; still higher, namely on the level of the urethra, there is the constrictor urethræ.

But the urethra is an inch below the point of the arch; what, therefore, blocks up the remainder of the arch above it? A strong aponeurotic septum, which we may call, if we please, the triangular ligament. This does not appear now, but we shall see it presently.

51. *Deep perineal fascia.*—Proceeding, in the next place, to examine the truth of what has been said, we should first remove from the stratum its layer of fascia. This, we know, is called the *deep perineal fascia.** Though the chief points concerning it have been already alluded to, it may be well again to mention that it is attached to the pubic arch, that it not only strengthens the muscular stratum, but gives origin to some of its fibres, and that, a little above the level of the anus, it is closely connected with the more superficial fascia of these parts. Thus, then, to use a coarse illustration, the superficial and deep fasciæ of the perineum form a kind of sac, of which the bottom is just above the level of the anus, while the sides are represented by the bones. The only outlet from the sac is towards the penis and scrotum; and this is precisely the course which urine takes when, from ulceration or rupture of the urethra, it is effused into the perineum.

* Some anatomists call this fascia the triangular ligament. But this term should be restricted to the strong aponeurosis which blocks up the pubic arch *above* the urethra.

The origin of the levator ani cannot be seen, but we observe the insertion of its anterior fibres into the central line of the perineum for a short distance in front of the anus.

52. The *transversus perinei profundus* is generally thin and delicate, but it varies in its degree of development in different subjects. It arises from the bone on either side about half way up the arch, and then its fibres spread out towards the central line, and block up the perineum behind the bulb. The meeting of the fibres of opposite sides in the centre is not apparent unless the bulb be raised: this, however, requires careful dissection, since there is a close connection between them.

53. *Constrictor urethræ.*—This muscle surrounds and supports the urethra in its passage beneath the pubic arch.* Its principal attachment is to the ramus of the pubes on either side; from thence its fibres pass, some above, some below the urethra, and a few of them completely encircle it. To obtain the best perineal view of the muscle, we should cut through the spongy part of the urethra about three inches above the end of the bulb, and dissect it from the corpus cavernosum penis. Thus, the upper fibres of the constrictor will be exposed; to see the lower, it is only necessary to raise the bulb. This view of the muscle, however, gives us, after all, but a very inadequate idea of its extent and importance. In the examination of it on the pelvic side, we shall find that it forms a complete muscular covering for the urethra between the prostate and the bulb. It is chiefly through its agency that we are enabled to retain the urine.

54. *Cowper's glands.*—These glands are embedded, one on either side, immediately behind the bulb, in the substance of the

* The resistance which is sometimes met with to the passage of the catheter beneath the pubic arch is caused by the spasmodic contraction of the constrictor urethræ; therefore, it need hardly be said that anything like violence is more likely to increase than remove the obstacle. The bulbous part of the urethra, not being fixed like the muscular, allows the point of the instrument a certain latitude of motion, and it is consequently very apt to be pushed forward on one or other side, in the form of a pouch, before the muscular part has had time to relax. This is the reason why many surgeons draw the penis forwards in the introduction of the catheter.

transversus profundus. Each consists of a cluster of little glands. Their collective size is about that of a pea, but it varies in different individuals. From each a slender duct runs forwards, and, after a course of about one inch, opens into the under surface of the spongy part of the urethra. Their use is to furnish a secretion accessory to the function of generation.

55. *Pudic artery and its branches.*—About an inch and a half above the tuber ischii, we can feel the trunk of the pudic artery; but we cannot see it, nor draw it out, for it is securely lodged in a fibrous canal. As we trace it upwards, we find that it gradually approaches the border of the arch till it arrives at the root of the penis; then, running along the upper surface of this organ, it is eventually distributed to the glans. Its external hæmorrhoidal (§ 45) and superficial perineal branches (§ 47) have been already described; but its most important branch is the artery of the bulb.

a. The *artery of the bulb* is one of considerable size: we trace it across the arch, through the substance of the transversus profundus, and generally find that before it enters the bulb it divides into two or three branches. It also sends a little branch to Cowper's glands. From the direction of this artery it will at once strike the attention that there is great risk of dividing it in lithotomy. If the artery run along its usual level, and the incision be not made too high in the perineum, then indeed it is out of the way of harm. But, supposing the reverse, the artery cannot escape; and its size is such that it might occasion fatal hæmorrhage. If it be asked, how often does the artery run along a dangerous level? we answer, about once in twenty subjects; and there is no possibility of ascertaining this anomaly beforehand.

b. The *artery of the crus penis* is given off after that of the bulb. It ascends for a short distance under cover of the arch, but soon enters the crus.

c. To see the continuation of the pudic artery along the dorsum of the penis, we must dissect the penis from its attachment to the symphysis pubis. The artery should be traced down to the glans: we shall find that it forms a complete arterial circle round the corona glandis, giving off numerous ramifications to the papillæ on the surface.

56. Respecting the *pudic nerve* little need be said, excepting that it corresponds both in its course and branches with the artery. It gives off its external hæmorrhoidal, and its superficial perineal branches,—a small one to the bulb, and another still smaller to the crus penis; but the main trunk of the nerve runs with the artery along the dorsum of the penis to the glans, and we cannot fail to be struck with its large size. In its passage it supplies the integuments of the penis, and sends one or two branches into the corpus cavernosum. But this part of the penis also receives nerves from the sympathetic system.

57. Lastly, the penis being dissected from the upper part of the pubic arch, we have to notice the *triangular ligament.* It is nothing but a strong fibrous membrane which blocks up what is left of the arch above the constrictor urethræ. At the lower part of it there are several apertures which permit the great dorsal veins of the penis to pass into the plexus of veins around the prostate.

ANATOMY OF THE SIDE VIEW OF THE PELVIC VISCERA.

58. To make a side view of the pelvic viscera, one of the innominate bones—say the left—should be removed in the following manner:—Detach the peritoneum and the levator ani from the left side of the pelvis; saw through the pubes about two inches from the symphysis, and cut through the sacro-iliac symphysis; then, by drawing the legs apart, and cutting through the pyriformis, sacro-ischiatic ligaments, and ischiatic nerves, the innominate bone comes away easily enough. This done, the rectum, or at all events its lower part, should be distended with horse-hair, and the bladder blown up through the ureter. Lastly, a staff should be passed through the urethra into the bladder.

We presume the learner to be already familiar with the manner in which the peritoneum passes from the front of the rectum to the lower part of the bladder, and thence over the back of the bladder to the wall of the abdomen. We presume also a knowledge of the recto-vesical pouch and the practical points concerning it; else refer to § 41, *b*. It is only necessary to observe, further, that

the several peritoneal connections of the bladder are called its false ligaments; *false* in contradistinction to the *true*, which are formed by the proper fascia of the pelvis, and really do fasten the neck of the bladder in its proper position. The false ligaments, then, are—1, the *posterior*—two peritoneal folds produced, one on either side the recto-vesical pouch by the fibrous remains of the umbilical arteries; 2, the *anterior*, produced by the passage of the peritoneum from the bladder to the abdominal wall; and, lastly, the *lateral*, produced by its reflexion from the side of the bladder to the side of the pelvis.

59. *Pelvic fascia.*—The pelvic fascia comes next under consideration. This constitutes the true ligaments of the pelvic viscera, supporting and maintaining them in their proper position. In order to expose it, we need only remove the peritoneum on that side of the pelvis which has not been disturbed. In doing so, we cannot but notice the abundance of soft and loose cellular tissue which is interposed between the peritoneum and the fascia, evidently for the purpose of allowing the bladder to distend with facility. Whenever urine gains access to this cellular tissue, it is almost sure to produce the most disastrous consequences; therefore, in all operations on the perineum, it is of the utmost importance not to injure the fascia in question.

We naturally consider, 1, to what parts of the pelvis the fascia is attached; and, 2, the manner in which it is reflected on the organs.

Beginning, then, in front, we find that the fascia is attached to the body of the pubes; from thence we trace its attachment along the side of the pelvis, just above the obturator foramen, to the greater ischiatic notch; here it becomes gradually thinner, covers the pyriformis muscle, and is lost on the sacrum. Such is an outline of its pelvic attachment, so far only as it is at present visible. Now let us follow it on to the viscera.

From the pubes the fascia is reflected over the prostate and the neck of the bladder, so as to form on either side of the symphysis a well-marked prominent band, called the *anterior true ligament* of the bladder. From the side of the pelvis it descends over the levator ani, and is reflected on to the side of the bladder; here it forms what is called the *lateral ligament* of the bladder.

So far there can be no difficulty. But that part of the fascia which is in every point of view the most important still remains to be examined. The fact is, that it forms a complete capsule for the prostate gland and neck of the bladder. Now we will endeavour to give a simple idea how this capsule is constructed. In front, the fascia is attached round the margin of the pubic arch; from thence it passes backwards, and is gradually lost round the neck of the bladder. Taking it as a whole, it forms a kind of case, which encloses not only the prostate and neck of the bladder, but also the prostatic plexus of veins, and the beginning of the muscular part of the urethra. Towards the perineum, the case is closed by the stratum of muscle and fascia which blocks up the pubic arch, and constitutes what we have called the floor of the perineum. This stratum must of necessity be divided in the lateral operation of lithotomy; but in passing the knife through the prostate into the bladder, the greatest care should be taken not to injure the capsule alluded to, and for reasons already assigned.

If, with other anatomists, we were to describe this capsule piecemeal, then we should say that it consists of so many ligaments: its upper part would be formed by the anterior ligaments of the bladder, its sides by the lateral ligaments* of the prostate, and its lower part by a horizontal layer of fascia interposed between the prostate and the rectum.†

* These ligaments extend from the ramus of the ischium to the side of the prostate, and sometimes go by the name of ischio-prostatic.

† Denonvilliers is the only anatomist who puts these several portions of the fascia together, and describes them as a whole. He says: "La prostate et la portion membraneuse de l'urètre sont placées au centre, comprises entre des plans fibreux supérieurs, inférieurs et lateraux, enveloppées de toutes parts, et engainées à la manière des muscles. On conçoit donc comment la portion membraneuse de l'urètre se trouve contenue dans une sorte de caisse irrégulièrement quadrilatère." — *Propositions d'Anat. et de Phys.*, Paris, 1837.

If the natural question be asked, How is all this to be demonstrated? we answer, that an express dissection must be made. The pubic arch must be removed *en masse* with the prostate, bladder, rectum, and penis. All that we

The use of this capsule is, obviously, to fasten down the neck of the bladder and the prostate, and to maintain them in their proper position with regard to the pubic arch. But for this, the prostate would rise with the distending bladder, elongate the urethra, and thereby materially obstruct the free passage of the urine.*

Proceeding with the dissection, we should now make ourselves familiar with the general position of the pelvic viscera, and the plexus of veins about them.

60. *General position of the pelvic viscera in the male.*—In making a side view of the pelvic viscera, they will be found so surrounded by veins and loose cellular tissue, that he who dissects them for the first time will meet with considerable difficulty in discovering their definite boundaries. It is easy enough to trace the rectum along the back of the pelvis. The position of the bladder, too, in front of the rectum, and immediately behind the symphysis pubis, is sufficiently obvious. At the lower and front part of the bladder,—in other words, at its neck, there is a gland called the prostate, through which the urethra passes. In the cellular tissue, between the bladder and the rectum, there is, on either side, a convoluted tube called the vesicula seminalis; and directly on the inner side of each vesicula there is the seminal duct or vas deferens. Before we describe these several parts in detail, it is necessary to say a few words about the large tortuous veins by which they are surrounded.

61. *Plexus of veins.*—Beneath the pelvic fascia about the prostate and the neck of the bladder, there are a number of large and tortuous veins, which form, by their mutual communications, the prostatic and the vesical plexuses. They empty themselves, on either side, into the internal iliac. In early life they are not

have, then, to do, is to reflect on either side the pubic origin of the levator ani, and to raise the prostate from the rectum.

* In cases of extreme distension of the bladder, the urethra does in some rare instances become elongated to a very considerable extent; so that a very long catheter is required to reach the bladder.—Consult M. Deschamps, Traité de l'Operation de la Taille, tom. i. p. 221.

much developed, but as puberty approaches they gradually increase in size; and any one not familiar with the anatomy of these parts would hardly credit the volume which they sometimes attain in aged individuals.* They communicate freely with the inferior hemorrhoidal plexus, or veins about the anus, and they receive the blood returning from the penis through the large veins which pass under the pubic arch. This is one of the reasons why the prostatic plexus is so capacious.

It will suggest itself, that if, in lithotomy, the incision be carried beyond the limits of the prostate, the great veins around it must necessarily be divided: these, independently of any artery, are quite sufficient to occasion very serious hemorrhage.

62. *Levator ani.*—This most important muscle in the fabric of the lower outlet of the pelvis forms a kind of moveable floor for the support of the rectum. In order to see it, the pelvic fascia must be reflected from its inner surface; but it requires a good deal of dissection before the whole length and breadth of the muscle can be thoroughly exposed. We observe that it arises from the pubes near the symphysis, also from the spine of the ischium, and from a white line† extending pretty nearly straight between these points of bone. But besides this, we find that a certain portion of the muscle arises from the anterior ligaments of the bladder. From this extensive origin the fibres descend, and are inserted thus:—The anterior meet their fellow in the middle line of the perineum in front of the anus; and we may remember to have seen them contributing to form the floor of this region; the next are lost on the outside of the sphincter ani; while the posterior, and by far the

* In old subjects they often contain phlebolites, or vein-stones. These are hard round bodies about the size of a small pea, and consist of concretions of earthy matter.

† This line, in the erect position of the body, is nearly horizontal. It is generally said that the pelvic fascia splits here into two layers, one of which lines the inner surface of the levator ani, the other covers the obturator internus. Since this description tends rather to complicate the matter than otherwise, and besides, does not exactly tally with nature, we think it better omitted.

greater part, terminate some beneath, and some on the side of the rectum.

If this insertion be rightly understood, we see how it is that the levatores ani together form a kind of sling for the support of the rectum. Their name implies their power of raising the rectum and the floor of the pelvis, after the viscera have been pushed down by the combined action of the abdominal muscles and the diaphragm.

a. Coccygeus.—This muscle is but a continuation of the levator ani. It arises from the spine of the ischium, gradually expands, and is inserted into the side of the coccyx, which it obviously supports.

63. *Rectum.*—We have already directed attention to the general course of the rectum,—namely, that it enters the pelvis on the left of the sacrum, and that it describes a curve corresponding to the axis of the pelvis. Nothing further on this subject need be added, except that, just before its termination, the bowel curves downwards so that the anal aperture is dependent. The rectum is not throughout of equal calibre. Its capacity becomes greater as it descends into the pelvis; and, immediately above the sphincter, it presents a considerable dilatation. This dilatation is not material in early life, but it increases as age advances. An adequate idea of it cannot be formed unless the bowel be fully distended. Under such circumstances the rectum loses altogether its cylindrical form, and bulges up on either side of the prostate and the base of the bladder. For this reason it is essential that the rectum be always emptied before the operation of lithotomy.

The relations of the lower part of the rectum—that, namely, included between the recto-vesical pouch and the anus—deserve the most attentive consideration. To put this matter in the most practical light, we will suppose the forefinger to be introduced into the anus, and a catheter in the urethra. The first thing felt through the front wall of the bowel is the muscular part of the urethra. It lies just within the sphincter, and is about ten lines in front of the gut. About one and a half or two inches from the anus the finger comes upon the prostate gland; this is in close contact with the gut, and is readily felt on account of its hardness;

moreover, by moving the finger from side to side we recognize its lateral lobes. Still higher up, the finger goes beyond the prostate, and reaches the "trigone" of the bladder: the facility with which this can be examined depends of course upon the length of the finger and the amount of fat in the perineum. These several relations are practically important. They explain why, with the finger in the rectum, we may sometimes facilitate the passage of a catheter along the urethra, obtain valuable information respecting the condition of the prostate, and, in some instances, even raise a stone from the bottom of the bladder so as to bring it in contact with the forceps. They explain, too, how the bladder may be punctured from the rectum; but this has been already alluded to elsewhere.

Below the meso-rectum the posterior part of the gut is connected to the sacrum and coccyx by an abundance of loose cellular tissue, which allows its easy distension. This is the reason why fistulous passages are so apt to burrow in this direction.

64. *Bladder.*—This viscus, being a receptacle for the urine, must necessarily vary in size, and accordingly we find that the nature of its connections and coats are such as to permit this variation. When contracted the bladder sinks into the pelvis behind the pubic arch, and is completely protected from injury. But, as it gradually distends, it rises out of the pelvis into the abdomen, and, in cases of extreme distension, may reach nearly up to the umbilicus.* Its outline can then be easily felt through the walls of the abdomen. The form† of the distended bladder is more or

* When the bladder is completely paralyzed it becomes like an inorganic sac, and there seems to be no limit to its distension. Haller found, in a drunkard, the bladder so dilated that it would hold twenty pints of water. (Elem. Phys. art. Vesica.) Frank saw a bladder so distended as to resemble ascites, and evacuated from it twelve pounds of urine. (Oratio de Signis morborum, &c. &c. Ticini, 1788.)

W. Hunter, in his Anatomy of the Gravid Uterus, has given the representation of a bladder distended nearly as high as the ensiform cartilage.

† In all animals with a bladder, the younger the animal the more elongated is the bladder. This is indicative of its original derivation from a tube, i. e. the

less oval, and its long axis runs nearly parallel with that of the brim of the pelvis; *i. e.* the axis, if produced, would pass superiorly through the umbilicus, or thereabouts, and inferiorly through the end of the coccyx: we speak, of course, in reference to the adult, for in the child, the bladder being more in the abdomen, the direction of its axis is more vertical accordingly.

The quantity of urine which the bladder will hold without much inconvenience varies in different cases. As a general rule it may be stated at about a pint. A good deal depends upon the habits of the individual; but there are some persons who have, naturally, a very small bladder, and are on that account obliged to empty it more frequently.

In young persons the lowest part of the bladder is the neck, or that part which joins the prostate. But in proportion as age advances, the bottom of the bladder gradually deepens so as to form a sort of well or pouch behind the prostate. In old subjects, more particularly if the prostate be enlarged, this pouch is apt to become of considerable depth, and render micturition tedious. It sometimes happens that a stone exists in the bladder, and yet none can be felt; the reason of which may possibly be that the stone has lodged in such a pouch below the level of the neck of the bladder, and therefore escapes the detection of the sound. Under these circumstances it is necessary to place the patient on an inclined plane with the pelvis higher than the shoulders, and then the stone falls out of the pouch, and is easily recognizable.

Postponing, for the present, the examination of the coats of the bladder, we pass on to notice the ureters, vasa deferentia, and vesiculæ seminales.

65. The *ureter* is a tube about eighteen inches long, which conveys the urine from the kidney to the bladder. In the dissection of the abdomen we saw it descending along the psoas muscle, and crossing the division of the common iliac artery. If we now trace

urachus. In the infant the bladder is of a pyriform shape, as it is, permanently, in the quadruped; but as we assume more and more the perpendicular attitude, the weight of the urine gradually makes the lower part more capacious.

it down to the bottom of the bladder we shall find that it enters it about one inch and a half behind the prostate, and about two inches from its fellow of the opposite side. By and by it will be seen that the tube perforates the bladder very obliquely, so that the aperture, being valvular, allows the urine to flow into, but not out of the organ.

66. The *vas deferens* is the tube which conveys the seminal fluid from the testicle into the prostatic part of the urethra. It ascends at the back part of the spermatic cord through the inguinal canal into the abdomen; then, leaving the cord, it curves downwards over the side of the bladder, gradually approaching nearer to the middle line. Before it reaches the prostate it becomes very tortuous, and is joined by the duct of the seminal vesicle. The common duct thus formed (*ductus communis ejaculatorius*) terminates in the lower part of the prostatic portion of the urethra. In point of size and hardness the vas deferens has very much the feel of whip-cord.

67. *Vesiculæ seminales.*—These are situated, one on either side, between the bladder and the rectum. Strictly speaking each is a tube, but this is so convoluted that it looks more like a little sacculated bladder. When rolled up, the tube is not more than two and a half inches long, but when unravelled it is more than twice that length, and about the size of a small writing quill. We may observe that several blind tubes, or cæcal prolongations, proceed from the main one, after the manner of a stag's horn. The vesiculæ seminales do not run parallel, but they diverge from each other posteriorly like the branches of the letter V, and each lies immediately on the outer side of the vas deferens into which it leads.

If one of these vesicles be opened we find that a brownish-coloured fluid escapes from it. This is presumed to be in some way or other accessory to the function of generation.*

68. *Prostate gland.*—This glandular organ is situated at the

* The vesiculæ seminales are but imperfectly developed till the age of puberty. In a child of three years of age they can hardly be inflated with the blowpipe.

neck of the bladder, and surrounds the first part of the urethra. In the healthy adult it is about the size and shape of a chestnut. Its lower flat surface rests upon the rectum, and the apex is directed forwards. We have already seen that it is surrounded by a plexus of veins (§ 61), that it is maintained in its position by the pelvic fascia (§ 59), and that on either side of it are the levatores ani. It is about three-quarters of an inch below the symphysis pubis, and about two inches from the anus, as one may easily ascertain by the finger. The wide, that is the transverse diameter, is about one inch and a half; the vertical is about half an inch less. But the gland varies so much in size at different periods of life, and even in different individuals of the same age, that we cannot specify its dimensions with precision. In the child it is not developed, or at all events is very small: it gradually grows towards puberty, and increases in size with advancing age. Of its minute structure we say nothing at present, but pass on to examine the urethra in its passage under the pubic arch.

69. *Anatomy of the urethra in its passage under the pubic arch.*—The urethra, in its passage under the arch of the pubes, is surrounded by muscular fibres; this, therefore, may very properly be called the muscular part of the urethra, though it commonly goes by the name of the membranous. It comprises so much of the canal as is intermediate between the prostate and the bulb. Upon the whole it is about one inch in length, though it is somewhat longer on the upper than the lower surface, in consequence of the encroachment of the bulb. It is about an inch below the symphysis pubis, and nearly the same distance from the rectum; we observe, however, that it is not equidistant from the rectum at all points, because of the downward bend which the gut makes towards the anus.*

At the same time, it must be confessed, that in the ordinary routine dissection of the pelvis we can obtain but a very imperfect and unsatisfactory insight into the anatomy of this important part

* If a clean vertical section were made we should see that the two canals form the sides of a triangular space, of which the apex is towards the prostate. This is sometimes called the recto-urethral triangle.

of the urethra. To understand it thoroughly the whole framework of the pubic arch should be removed from a fresh subject, so that the parts may be examined undisturbed, both on the pelvic and the perineal side. With such a preparation before us, we should reflect the levator ani from the arch, and make out the capsule of the prostate as described at § 59. Then, by cutting away the upper part of this capsule, in other words the anterior ligament of the bladder, we observe the great veins coming down from the dorsum of the penis. Beneath these veins, with a little careful dissection, we discover a stratum of muscular fibres over the upper part of the urethra; a similar stratum runs below it, and a few fibres completely encircle it. The fibres, collectively, constitute the *constrictor urethræ**, or Santorini's muscle, and they are attached on either side to the descending rami of the pubes, and the lateral ligaments of the prostate.

70. INTERNAL ILIAC ARTERY AND BRANCHES.—From the division of the common iliac, this artery descends into the pelvis, and, after a course of about an inch and a half, divides nearly opposite the great sacro-ischiatic notch into two large branches. Of these, the posterior gives off the ilio-lumbar, lateral sacral, and glutæal arteries; while the anterior gives off the obturator, vesical, ischiatic, and pudic, also the uterine and vaginal in the female. Such is their usual order: at the same time, these several branches, though constant in their general distribution, are very apt to vary in different subjects as to their place of origin.

a. The *ilio-lumbar* is analogous to the lumbar branches of the aorta. It ascends outwards beneath the psoas, sends branches to this muscle and the quadratus lumborum, and then, running near the crest of the ilium, supplies the iliacus muscle, and finally inosculates with the circumflexa ilii (§ 37, *b.*)

b. The *lateral sacral* descends perpendicularly in front of the sacral foramina, and near the coccyx inosculates with the middle

* This muscle was first accurately described and delineated by Santorini (septemdec. tabulæ), and afterwards by Müller in his monograph (Ueber die organ. Nerv. der männlich. Geschlechtsorgane), and by Guthrie in his work on the anatomy and diseases of the neck of the bladder. These authors agree in essentials respecting the muscle, though they differ in minor points.

sacral artery. It gives branches to the pyriformis, the bladder, and rectum, and others which enter the sacral foramina for the supply of the cauda equina. But the artery is always of small size, and sometimes absent.

c. The *glutæal* is by far the largest branch. It passes almost immediately out of the pelvis through the great ischiatic notch, above the pyriformis muscle, aud then divides into branches for the supply of the great muscles of the buttock. These we follow in the dissection of the thigh.

d. The *obturator* artery runs along the side of the pelvis, below the corresponding nerve, to the upper part of the obturator foramen, and then, passing through it, is distributed to the muscles of the thigh. While in the pelvis it gives off a small branch to the iliacus muscle, and another which ramifies on the back of the pubes.

But the obturator artery does not in all subjects take the course above stated. It often arises from the external iliac near the crural arch, or else by a short trunk in common with the epigastric. Under these circumstances, in order to reach the obturator foramen, it generally descends on the *outer* side of the femoral ring. Instances, however, every now and then occur, where it makes a sweep round the *inner* side of the ring; so that three-fourths of the ring, or, what comes to the same thing, of the mouth of a femoral hernia, would in such a case be surrounded by a large artery.*

e. The *ischiatic* artery is somewhat smaller than the glutæal. It proceeds over the pyriformis and the sacral plexus, to the lower border of the great ischiatic notch, through which it passes out of the pelvis to the buttock, where it will be followed hereafter.

f. The *pudic* artery is destined to supply the perineum and the penis. It passes out of the pelvis through the greater ischiatic notch, below the pyriformis, crosses the spine of the ischium, and re-enters the pelvis through the lesser notch. It then ascends on the inner side of the obturator internus muscle towards the pubic arch, where it gives off branches to the several parts of the penis.

* The museum of St. Bartholomew's Hospital contains two examples of double femoral hernia in the male, with the obturator arising on each side from the epigastric. In three out of the four ruptures the obturator runs on the inner side of the mouth of the sac. (See Preparations 55, 69, Series 17.)

In its passage over the obturator muscle it is enclosed in a strong tube of fascia, and is situated about one inch and a quarter above the tuberosity of the ischium. Here it might for a time be effectually compressed. The branches of the pudic artery were described in the dissection of the perineum (§ 55).

Unfortunately, however, for operative surgery, the pudic artery sometimes takes a very different course. Instead of passing out of the pelvis, it may run by the side of the prostate gland to its destination; or, which comes to nearly the same thing, one of the large branches of the pudic may take this unusual course, while the pudic itself is regular, but proportionably small. All practical anatomists are familiar with these varieties, and we seldom pass a winter session without meeting with one or two examples of them. It need hardly be said, that lithotomy, under such conditions, might be followed by fatal hæmorrhage.

g. The *vesical**and middle *hemorrhoidal* arteries are variable as to their number and origin. They come from the pudic or the ischiatic, and ramify irregularly on the side of the rectum, the bladder, the vesiculæ seminales, and the prostate.

h. The *middle sacral artery* is a very diminutive prolongation of the aorta down to the coccyx. It becomes gradually smaller as it descends, and finally inosculates with the lateral sacral artery.

Respecting the *veins* in the pelvis, we have little to say more than that they correspond with the arteries. The remarkable plexus of veins about the prostate, neck of the bladder, and rectum, has been already described (§ 61.)

71. Nerves of the pelvis.—We should examine, first, those nerves which proceed from the spinal cord, and then those derived from the sympathetic system.

Sacral plexus.—Five† sacral nerves proceed from the spinal

* While on the subject of arteries supplying the bladder, it should be mentioned that the upper part of this organ is generally supplied by what is called the *superior vesical.* This is a small artery proceeding from the all but obliterated umbilical; and from it a still smaller is given off, which accompanies the vas deferens along the spermatic cord.

† Some anatomists describe a sixth, or "coccygeal" nerve, but this is only a division of the fifth sacral, and supplies nearly the same parts.

cord through the corresponding sacral foramina. The upper four, from their large size, at once attract observation; but the fifth, that, namely, which perforates the coccygeus muscle, is small, and not easily found. Now, the four upper nerves, together with a branch from the last lumbar (*lumbo-sacral*) unite to form the great sacral plexus. The great formative nerves of the plexus lie on the pyriformis muscle, beneath the branches of the internal iliac artery, and they gradually coalesce to form the ischiatic nerve, which passes out at the back of the pelvis for the supply of the flexor muscles of the inferior extremity. The other branches of the plexus are in a general way as follows.

a. The *superior glutæal* nerve proceeds from the lumbo-sacral, leaves the pelvis with the glutæal artery, and supplies the glutæus medius and minimus, and the tensor fasciæ femoris.

b. The *pudic* nerve runs with the pudic artery, and, like it, supplies the rectum, perineum, and penis. The pudic commonly gives off the branch for the obturator internus muscle, but this is often a distinct branch from the plexus. Under any circumstances the branch in question leaves the pelvis with the artery, and re-enters with it to reach the muscle.

c. The *branches for the pelvic viscera* are very small, and require a special dissection. They proceed chiefly from the third and fourth sacral nerves, and form an intricate plexus about the bladder, prostate, and rectum.

d. Lastly, the sacral plexus supplies the pyriformis, the levator ani, the coccygeus, and the cutaneous sphincter of the anus.

72. *Sympathetic nerve.*—From the lumbar region we trace the sympathetic nerve into the pelvis, along the front of the sacrum. In this part of its course its characteristic ganglia vary in number from three to five. The nerves of opposite sides unite in front of the coccyx, and form a loop in the middle line; and here we find a "*ganglion impar.*"

The general plan upon which the sympathetic nerves are distributed in the pelvis is precisely similar to that in the abdomen. That is to say, each ganglion receives one or two filaments from a spinal nerve, and then gives off its branches to the viscera. The visceral branches are exceedingly fine and delicate, and cannot be

effectually traced unless the parts have been previously hardened in spirit. They accompany the arteries supplying the respective organs, and are called severally the vesical, prostatic, and inferior hemorrhoidal plexuses.

According to the accurate dissections of Müller,* it is determined that the vesical filaments of the sympathetic do not stop at the prostate, but pass on beneath the pubic arch into the corpus cavernosum penis. Thus the erectile tissue of the intromittent organ is brought directly within the influence of the sympathetic system.

STRUCTURE OF THE BLADDER, PROSTATE, URETHRA, AND PENIS.

The parts are presumed to have been collectively taken out from the pelvis, and the partial peritoneal covering of the bladder to have been removed.

73. The *bladder* is composed of two coats, a muscular and a mucous; these are connected by an intermediate layer of pretty firm cellular tissue, out of which some anatomists make a third coat, and call it the cellular.

a. The *muscular* is the outside coat. It consists of bundles of muscular fibres crossing each other in various directions. Their colour and degree of development vary according to the condition of the individual, and according to whether he has suffered during life from irritation of the bladder, or any obstruction to the flow of the urine. The general direction of the fibres is simply as follows: —An outer layer arises from the circumference of the prostate, and from thence its fibres spread out longitudinally over the bladder, chiefly, however, in front and behind. Under this there is a layer of more or less circular fibres, but more especially near the neck. Towards the sides of the bladder we observe that the two sets of fibres have a less definite arrangement, and they form a kind of network: these, therefore, are the weakest parts of the bladder, and more liable to the formation of pouches.†

* " Ueber die organischen Nerven der erectilen männlichen Geschlechtsorgane des Menschen und der Säugethiere, Berlin, 1836.

† These pouches arise in the following manner:—A portion of mucous

b. The bladder should be laid open by a perpendicular incision along its front surface, for the purpose of examining its interior. In a recently contracted bladder, the mucous membrane would be disposed in irregular plaits or folds; these, however, disappear when the bladder is distended. Under ordinary circumstances the membrane is perfectly pale, but when either inflamed or successfully injected it becomes of a bright red colour. If a piece of the injected membrane, especially when selected from near the neck of the bladder, be placed under the field of a microscope, its surface is seen to be studded with follicles, and protected by a layer of scaly epithelium.

c. The *orifice of the urethra* is situated at the lower and anterior part of the bladder, not at the most dependent part which forms the well behind the orifice, and in which urine, as before mentioned, is apt to accumulate in old persons. Though it appears small and contracted in the fresh bladder, yet if the little finger be introduced into it, we shall find that it will gradually dilate to a very considerable size. Immediately behind the orifice there is observed in some bladders a slight elevation, commonly called the *uvula vesicæ.* It is nothing more than a portion of the mucous membrane raised up by an accumulation of the submucous tissue, and is rarely of sufficient size to interfere with the passage of the urine. This is quite a different thing from enlargement of the third or middle lobe of the prostate, which we shall have occasion to notice presently.

d. The *orifices of the ureters* are about an inch and a half behind the urethra, and rather more than that distance apart. We see how obliquely these tubes perforate the coats of the bladder, slanting towards each other, and standing out in relief under the mucous

membrane is protruded through one of the muscular interstices, so as to form a little sac. This is small at first, but gradually increases in size, because, having no muscular coat, it has no power of emptying itself; generally speaking, several such sacs are met with in the same bladder, and they often contain calculi. Now, if a calculus, originally loose in the bladder, happen to become lodged in a pouch by the side of it, a sudden remission of the symptoms may ensue. Occurrences of this kind readily explain the boasted and apparent efficacy of lithontriptic medicines.

membrane.* Moreover, a little ridge proceeds from the orifice of each ureter down to the neck of the bladder, looking like a continuation of the ureter itself. If the mucous membrane be removed from these ridges, we find that they are produced by muscular fibres. Sir Charles Bell,† who first drew attention to them, believed them to be of use in regulating the orifices of the ureters, and named them "the muscles of the ureters."

e. The ridges, converging from the ureters, together with an imaginary horizontal line drawn between their orifices, include a triangular area called by the French anatomists the *trigone vesicale.* The mucous membrane of this area is always firmly adherent to the subjacent tissue, and is therefore perfectly smooth, and free from wrinkles. It is more richly provided with blood-vessels and nerves than the rest of the bladder, and is in consequence endowed with more delicate sensibility. This is the reason why a stone gives more pain when the bladder is empty, and why it is more painful in the erect than in any other position of the body.

74.—*Prostate.* Having already (§ 68) examined the form, size, relations, and other circumstances connected with this gland, we need only mention here that it is commonly described as consisting of two lateral and symmetrical lobes; but in the healthy state of parts the learner will hardly distinguish anything like a division between them. There is, however, sometimes a third or middle lobe.‡ It is, generally speaking, quite rudimentary, and is situ-

* This slanting of the ureters serves all the uses of a valve. The urine enters the bladder, drop by drop, but cannot return, because the internal coat is pressed against the other side of the orifice, so as to stop it. When the bladder becomes thickened, in consequence of difficulty in passing the water, it sometimes happens that the ureters lose their valvular direction, so that the urine, when the bladder contracts, is partly forced back up the ureters; the result is, that they become dilated, and so does the pelvis of the kidney.

† Med. Chir. Trans., vol. iii. He says, "These muscles guard the orifices of the ureters by preserving the obliquity of the passage, and pulling down the extremities of the ureters according to the degree of the contraction of the bladder generally."

‡ Attention was first attracted to this middle lobe, in England, by Sir Everard Home, whose account of it is published in the Philos. Trans. for

ated behind the lateral lobes, between the neck of the bladder and the seminal ducts.

a. Make a longitudinal incision through the prostate in order to expose the urethra. We notice that the canal does not run exactly in the centre of the gland, but rather nearer to its upper surface; nor is it of the same calibre throughout. It forms a kind of sinus in the interior of the prostate, as though the gland had been purposely hollowed out; and this is what anatomists mean when they speak of the "sinus of the prostate." Along the floor of this sinus we notice a longitudinal ridge, which is broad and elevated behind, but gradually loses itself forwards in a narrow point. This is called the crest of the urethra, and the most prominent part of it is commonly named the *caput gallinaginis,* from its supposed resemblance to the head of a woodcock. The seminal ducts open close to each other, one on either side of this prominence.

b. Immediately in front of the caput gallinaginis, precisely in the middle line, we find a small opening, into which a probe should be passed, in order to ascertain that it leads backwards into a little cul-de-sac or pouch in the substance of the prostate. This pouch is generally described as the analogue of the uterus, and called the *utriculus;* but strictly speaking, it is the remains of the primordial sac out of which the parts were formed. It is of a pyriform shape, with the narrowest part at the orifice, and its length is about five or six lines. In a practical point of view it deserves attention, because in some persons it is large enough to catch the end of a small catheter.

c. Lastly, we have to notice the minute orifices of the proper ducts of the prostate,* and these are best seen on the floor of the

1806. The preparation prepared by Sir Everard in illustration is preserved in the Museum of the Royal College of Surgeons in London, Physiol. Series, No. 2,583 A. But the anatomy and effects of the enlargement of this part of the prostate gland is not a discovery of modern times. It was accurately described by Santorini in 1739, and subsequently by Camper, and is alluded to by Morgagni in the third book of his Epistles.

* In the ducts of the prostate we often find small calculi, of a brown colour, consisting of phosphate of lime. Cases are sometimes met with in which these calculi by degrees attain a considerable size, and distend the prostate into a kind of sac, which when examined by the rectum feels not unlike a bag of marbles.

sinus. Now the whole substance of the gland is permeated by the divisions and subdivisions of these ducts. They are not visible to the naked eye, but if one of them were thoroughly traced out with the microscope, it would be seen to terminate in a blind sacculated extremity, upon which the capillaries ramify in rich profusion.*

d. After what has been seen, it will naturally suggest itself, that any change in the dimensions of the prostate gland must in a greater or less degree influence the canal which runs through it. For instance, if the entire gland be uniformly enlarged, the canal will be lengthened in proportion; if the enlargement preponderate on this or that side, then the canal will deviate more or less from its ordinary course. In either case, however, a suitable catheter would pass without much difficulty into the bladder. But supposing the middle or third lobe to become enlarged, then there arises, at the very neck of the bladder, a tumor, which will, in proportion to its size, more or less obstruct the passage of the urine. In the efforts made, when such is the case, to introduce a catheter into the bladder, it sometimes happens that the end of the instrument is pushed right through this hypertrophied lobe.†

75. Respecting the internal structure of the *vesiculæ seminales,* we need only observe that their mucous membrane is lined by a scaly epithelium, and that it presents a beautiful reticular or honeycomb structure, not unlike that of the gall-bladder, only on a smaller scale: the purpose of this is to increase the extent of the secreting surface.

76. The *glands of Cowper* have already been examined in situ in the dissection of the perineum. We find them close to the urethra, one on either side, immediately behind the bulb. They consist of an aggregation of smaller glands, of which the collective size is somewhat larger than a pea. Each pours its secretion by a

* This was first demonstrated by Mr. Quekett. The same distinguished anatomist has also discovered that the secreting cells of the gland contain calculi of microscopic minuteness. He finds them, almost without exception, in the prostate at every period of life. For further detail concerning them consult the article "Prostate," in Todd's Cyclopædia.

† See in the Museum of St. Bartholomew's, Prep. 8 and 21, Series xxix.

single and very minute duct into the bulbous part of the urethra. The use of these glands would appear to be like that of the vesiculæ seminales and the prostate, namely, to pour into the urethra a fluid accessory in some way, which is not yet understood, to the function of generation. They are found more or less developed in all mammalia, and in some, as *e. g.* in the mole, they increase in size periodically with the testicle.

77. *Urethra.*—The urethra is the tube which leads from the bladder to the end of the penis, and serves not only as the excretory duct of the bladder, but transmits also the secretion of the testicles and the several glands accessory to generation. It is surrounded by different structures in different parts of its course, with most of which we are already familiar. The first inch, or thereabouts, is surrounded by the prostate gland; the second inch, which passes under the pubic arch, is surrounded by muscular fibre; the remainder of its course along the penis is surrounded by spongy, erectile tissue. Hence anatomists divide it into the prostatic, the muscular or membranous, and the spongy. The length of the whole is about seven or eight inches,* but, of course, this will vary according to the condition of the penis.

In its contracted state, the sides of the urethra are in close apposition. Since all that concerns this canal is important, we ought, when opportunity offers, to make transverse sections of it, in order to see how it looks in the different parts of its course. Through the glans it is flattened vertically, its two sides being in contact; through the prostate, too, it is nearly flat, except at the lower part, where its sides are kept asunder by the verumontanum, which projects upwards, leaving a furrow on each side. But throughout all the rest of its course the lining membrane is disposed in numerous longitudinal folds, which project into and accurately close the canal, precisely on the same plan as that by which nature closes the œsophagus. These longitudinal folds are plainly seen even when the urethra is slit open; indeed, they do not disappear

* In cases of extreme distension of the bladder, it is interesting to know that the urethra may become considerably lengthened by the ascent of the bladder. Of this examples are related by M. Deschamps, Traité de l'Opération de la Taille, tom. i. p. 221.

unless the canal be forcibly stretched contrary to their direction.*

If the urethra, in the adult, be laid open from end to end, we find that the canal is not of uniform calibre throughout, but that there is a difference in its width according to the structure of the parts which surround it. In its passage through the glans it is a little constricted, and, during life, admits of less dilatation than elsewhere, owing to the dense structure and higher sensibility of this part of the penis. From the glans the urethra gradually increases in width, for about three and a half inches down; it then decreases as it approaches and passes under the pubic arch, so that the muscular portion is *in appearance* the narrowest part of the canal.

But though the muscular part of the canal appear in its natural state narrower than the rest, yet it is demonstrable, by making casts of the urethra (*e. g.* with wax, fusible metal, or cold paint), that this part greatly exceeds the rest of the canal in its dilatability. Under such circumstances it is distended into a large oblong sinus measuring from one inch and a quarter to one inch and three-quarters in length, and in its transverse diameter, at the broadest part, rather more than half an inch. The narrowest part of the canal, as shewn by such casts, is at the junction of the muscular with the prostatic.† These diversities in the dimensions of the urethra do not exist in early life. A cast taken from a young child measures uniformly about one-fifth of an inch. The change which takes place in the muscular part of the urethra at the age of puberty is simultaneous with the development of the accessory organs of generation, to the secretions of which it serves as a receptacle, until acted on by the muscles which surround it.

* In a well injected urethra we observe that the ridges of the folds possess very few blood-vessels, while the furrows between them are exceedingly vascular. For the demonstration of this fact the author is indebted to Mr. Quekett.

† These statements are at variance with the opinion of Sir E. Home, Bell, Bichat, and most modern authors, who consider that the bulbous part of the urethra is the most dilatable, and that the most constricted part is at the junction of the bulbous and muscular. Any one, however, who will be at the trouble to repeat the accurate experiments performed by Mr. Briggs, may convince himself of the truth of what is asserted in the text.—See Briggs, On the Treatment of Strictures of the Urethra, &c. London, 1845.

The general direction of the urethra, when the penis hangs flaccid, is like the letter S reversed; but if the penis be held up straight, the canal forms only one curve* through the pubic arch, with the concavity upwards. The degree of this curvature varies at different periods of life. In the child, on account of the position of the bladder, the curve forms part of a much smaller circle than it does in the adult; but it gradually widens as age increases, and our catheters are shaped accordingly. At the same time the parts, when in a sound state, will always yield sufficiently to admit the introduction of even a straight instrument into the bladder.

Besides the ducts of the testicle and other accessory glands, a number of ducts open into the urethra, proceeding from little glands situated in the submucous tissue. These ducts, which are called the *lacunæ,* are just large enough to admit a bristle, and they all run in the same direction as the stream of the urine.

The urethra is lined by cylindrical epithelium, and near the orifice of the glans is provided with papillæ: this, therefore, is the most sensitive part. The lining membrane is laid upon a thin but firm substratum of fibrous tissue. The fibres run in a transverse direction, and are endowed with considerable elasticity,† so as not only to assist in propelling with greater force the column of urine, but also to contract the canal afterwards. This elasticity gives to the parts a certain springiness of which we are often sensible in the introduction of instruments.

* By taking plaster casts from vertical sections of the pelvis of adults, after the urethra had been injected with wax, Mr. Briggs found that the curve of the urethra formed an arc of a circle of three and a quarter inches in diameter, the cord being two inches and three-quarters, or rather less than one-third of the circumference.

The sharper bend of the urethra in the child was well known to Camper. "In recenter natis, vesica basi sua elatius sita, pedetentim descendit, unde necessario sequitur curvaturam urethræ majorem esse in junioribus quam in adultis."—Demon. Anat. Pathol. lib. ii. p. 13.

† This elastic structure is very marked in the urethra of the wether or the ox.

Lastly, the urethra is provided with a closely-set network of absorbent vessels,—a fact which has been demonstrated by the beautiful quicksilver injections of Panizza. *

78. ANATOMY OF THE PENIS.—The skin of the penis is remarkably thin and extensible, and is connected to the body of the organ by an abundance of loose cellular tissue, in which fat is never found. At the end of the penis the skin forms an ample fold, called the prepuce, or foreskin, for the protection of the glans; † and the thin fold which passes from the under surface of the glans to the prepuce is called the *frenum preputii.* If the glans be habitually covered by the prepuce, its surface partakes more of the appearance of mucous membrane than of common skin; but if the reverse, then the cuticular covering of the glans thickens and dries.

a. In a well-injected glans, we observe that the surface is covered by minute papillæ, just like the end of the finger, which are endowed with keen sensibility by the great dorsal nerves of the penis. Round its margin—in other words, round the *corona glandis*—there are a number of minute sebaceous glands which secrete an unctuous matter called *smegma preputii.* In cases of congenital phimosis, this is apt to collect in considerable quantity, and becoming rancid, irritates and excoriates the glans and prepuce, particularly in summer and in hot countries.

b. The chief bulk of the penis consists of erectile structures, named, from the appearance of their interior, the *corpora cavernosa.*

* Osservazioni antropo-zootom. &c., Pavia, 1830. This anatomist has also displayed by injections an extremely fine network of absorbents which cover the glans penis. The interstices of this network are smaller than the diameter of the tubes.

† When the foreskin is, from the time of birth, so tight that the glans cannot be uncovered, such a state is called a "congenital phimosis." This condition occasions no inconvenience in childhood, but is apt, after puberty, to become troublesome and painful, so that it is necessary to slit up the prepuce and set the glans at liberty. In persons who have a tight foreskin, it sometimes happens that, when the glans has been uncovered, the prepuce cannot be again drawn over it: this is called a "paraphymosis." The neck of the glans becomes tightly girt, great distension and inflammation are the consequences, and very serious results may ensue, unless the foreskin be reduced.

In a groove along their under surface runs the urethra, which is itself surrounded by a vascular spongy tissue, called the *corpus spongiosum;* an accumulation of this at the end of the organ forms the glans. These two structures, then,—the corpora cavernosa, and the corpus spongiosum,—together form the penis; though they appear closely united, yet they are quite distinct from each other, as may be easily ascertained by making a transverse section. Let us examine each separately.

c. The *corpora cavernosa* constitute more than two-thirds of the bulk of the penis. They commence posteriorly by two gradually tapering portions, called the *crura,* which are attached, one on each side, in an appropriate groove in the descending ramus of the pubes.* The crura converge, come into apposition at the root of the penis, and then run on, side by side, to form the body of the organ. Anteriorly, each terminates in a rounded end which is received into a corresponding depression in the glans, so that this latter fits on to them as it were like a cap.

If a longitudinal section be made through one of the corpora cavernosa, we observe that its interior is composed of a delicate reticular structure, surrounded by a thick fibrous coat made up of glistening fibres, closely set, and crossing in various directions. This coat forms a cylinder of adequate strength to protect and support the delicate structure within, and at the same time sufficiently elastic to allow the distension of the penis. Moreover, since the corpora cavernosa lie in apposition, this coat forms a longitudinal partition between them. The partition, however, is only complete near the root of the penis; along the rest of the organ there are a number of gaps in it, so that, upon the whole, it has somewhat the appearance of a comb; and for this reason it has been called the *septum pectiniforme.* Through this partition the vascular structure on the one side communicates freely with that on the other, and therefore both sides of the penis must become erect simultaneously.

* While speaking of the attachments of the penis, it should be mentioned that its upper part is connected to the symphysis pubis by an elastic ligament called the "ligamentum suspensorium penis."

And now let us examine the construction of the erectile, spongy looking tissue inside. The interior of the cylinder is occupied by a number of delicate elastic thread-like septa, which intersect each other in all directions, so as to form a multitude of minute cells. These communicate most freely with each other, as one may readily ascertain by blowing air into the penis. But they are not of equal size throughout the penis, for they are much smaller, and their component septa altogether thicker, at the root than they are towards the glans. All the cells communicate freely with the arteries. Under ordinary circumstances, that is when the penis is flaccid, they are comparatively empty ; but when, through appropriate stimulus, they become distended with blood, erection of the penis is produced.

Here two questions arise,—1. how does the blood get from the arteries into the cells ? 2. how does it return from the cells?

With regard to the first question. If the arteries of the penis be well injected, we find that the artery of each corpus cavernosum enters the inner side of the crus, and proceeds forwards near the septum, distributing numerous ramifications. These are supported in the middle of the fibrous threads, and after making several spiral turns, as it were for the purpose of being able to accommodate themselves to the varying size of the penis, discharge their blood at once into the cells. Besides the ramifications which feed the cells, there is a proper capillary system for the nutrition of all the parts concerned.

With regard to the second question. If a coloured fluid be injected into the corpus cavernosum, near the glans, it instantly fills all the cells, and returns partly through veins which pass out at the upper surface of the penis, and join the great dorsal vein, and partly through the deep veins of the penis, which leave the inner side of each crus.

d. The *corpus spongiosum* is the erectile tissue which surrounds the urethra as it runs along the penis. It commences in the middle of the perineum, in a bulb-like form, and at the end of the penis it is continuous with the glans. This is proved by the fact, that if we inject the spongy body, we fill the glans also, but not so if we inject the cavernous body. We observe that the urethra does

not enter the bulb, plump so to speak, and then pass on precisely through the middle of the spongy body, but that it runs all along nearer to its upper surface. The bulb, therefore, hangs more or less pendulous from the urethra. In old persons it hangs lower down than in children, and is consequently more exposed to injury in lithotomy.

The corpus spongiosum has a much thinner external coat than the corpus cavernosum. Its interior is composed of a plexus of minute tortuous veins. This is plainly demonstrated by injecting the dorsal vein of the penis with wax. In this way we not only fill the spongy body, but also the glans and the large veins which form the plexus round the corona glandis.*

e. The chief *nerves* of the penis are the pudic. By far the largest branches run along the dorsum of the organ to the outside ot the glans: a few only enter the erectile tissue of the organ. This, it has already been mentioned (§ 72), is supplied by filaments of the sympathetic nerve proceeding from the hypogastric plexus.

f. The *absorbent* vessels roceeding from the glans and the integument of the penis join the inguinal glands. The deeper set accompany the veins beneath the pubic arch, and join the glands in the pelvis.

THE DISSECTION OF THE FEMALE PERINEUM.

79. The *pudenda* in the female consist of folds of the integument, called the labia. Between these there is a longitudinal fissure which leads to the separate orifices of the urinary and genital canals.

80. *Labia majora.*—The pubic region is generally covered by an accumulation of fat, which is called the *mons veneris*. From this, two thick folds of skin descend, one on either side, constituting the labia majora. Their junction, about one inch above the

* In the museum of Royal College of Surgeons there is a beautiful preparation in which the glans penis is injected with quicksilver, clearly showing it to consist of a plexus of veins.—Physiol. Series, No. 2588 A.

anus, is called the commissure, or "frenulum labiorum:" it is generally torn in the first labour. The inner layer of the skin of the labium is thinner, softer, and more like mucous membrane than the outer: for this reason, whenever matter forms in the labium, the abscess is almost sure to burst on the inner side. Where the labia are in contact, we find that they are provided with a number of small sebaceous glands, of which the minute ducts are observable on the surface.

a. Labia minora.—By separating the external labia, we expose two smaller and thinner folds of skin, one on either side, termed the labia minora, or, by the old anatomists, the *nymphæ.* These folds converge anteriorly, and form a sort of hood for the clitoris, called the *preputium clitoridis;* posteriorly they are gradually lost on the inside of the labia majora. They never contain fat, like the labia majora, but are composed of a minute plexus of veins. Between the nymphæ and about the clitoris there are a number of glands which secrete the same kind of unctuous matter as about the corona glandis in the male.

In young persons, in whom the nymphæ are protected from the air and from friction by the external labia, they are soft, moist, and of a rose-red colour: but when hypertrophied, so as to project without the labia, they become like the common integument, and acquire a bluish colour from the distension of their veins.

Between the labia minora, and about a thumb's breadth below the clitoris, is the orifice of the urethra, or "meatus urinarius." Immediately below this is the vagina, of which the orifice is partially closed in the virgin state, by a thin fold of skin called the "hymen."

81. The *clitoris* resembles in form and structure the penis, but on a very diminutive scale. Like the penis, it is attached to the sides of the pubic arch by two crura, each of which is grasped by its own little erector muscle. The crura unite to form the body of the organ, which is tipped by a small glans. The glans is provided with extremely sensitive papillæ, and covered by a little prepuce. Its dorsal arteries and nerves are exceedingly large in proportion to its size, and have precisely the same course and distribution as in the penis. Its internal structure consists of a plexus of

blood-vessels, which freely communicate with those of the labia minora, for one cannot be injected without the other.

82. *Urethra.*— A smooth channel, called the vestibule, about three-quarters of an inch in length, leads from the clitoris down to the orifice of the urethra. This orifice is not a perpendicular fissure like that of the penis, but rounded and puckered, and during life it has a peculiar dimple-like feel, which assists us in finding it when we have occasion to pass a catheter. The learner should practise the introduction of the catheter in the dead subject, for the operation is not so easy as might at first be imagined, provided of course the parts are not exposed. The point of the forefinger of the left hand should be placed at the entrance of the vagina; and then the catheter, guided by the finger, slips, after a little manœuvring, into the urethra. The canal is rather more than an inch in length, and runs along the upper wall of the vagina; indeed, the two canals adhere so closely that we can feel the urethra through the vagina like a thick fleshy cord. Strictly speaking, the urethra is slightly curved with the concavity upwards, but for all practical purposes it may be considered straight. It is necessary, however, to be aware that its direction is not horizontal. In the unimpregnated state of the parts it runs nearly in the direction of the axis of the outlet of the pelvis; so that a probe pushed on in the course of the urethra would strike against the promontory of the sacrum. But after impregnation, when the uterus begins to rise out of the pelvis, the bladder is more or less raised also in consequence of their mutual connection; and therefore the urethra, in the latter months of utero-gestation, acquires a much more perpendicular course.

The female urethra is provided with a constrictor muscle, essentially similar, both in origin and arrangement, to that which surrounds the urethra in the male: indeed, we cannot convey a better idea of it than by saying that it is just like the male would be if cut short immediately behind the bulb. Though the prostate gland is wanting, yet there are minute glands scattered all round it, especially near the neck of the bladder. At the same time, it should be observed, that, in consequence of the wider span of the pubic arch, and the more yielding nature of the surrounding struc-

tures, the female urethra is much more dilatable than the male. We avail ourselves of this great dilatability in the extraction of calculi from the bladder.

83. The *vagina* is the canal which leads up to the uterus; at present only the orifice of it can be seen. It is surrounded by a sphincter muscle, which is easily displayed by removing the integument. The muscle is about three-fourths of an inch broad, and connected with the cutaneous sphincter of the anus in such a manner that they together form something like the figure 8.

a. The *hymen* is a thin fold of skin which, in the virgin, extends across the lower part of the entrance of the vagina, about half an inch behind the fourchette. In most instances its form is crescent-shaped, with the concavity upwards. But there are several varieties of hymen: sometimes there are two tegumentary folds, one on either side, so as to make the entrance of the vagina a mere vertical fissure;* or there may be a septum perforated by several openings (*Hymen cribriformis*), or by one only (*Hymen circularis*). Again, there may be no opening at all in it, and then it is called *Hymen imperforatus*. Under this last condition no inconvenience arises till puberty. The menstrual discharge must then necessarily accumulate in the vagina: indeed, the uterus itself may become distended, and to such a degree as even to simulate pregnancy.†

The presence of the hymen is not necessarily a proof of virginity, nor does its absence imply the loss of it. Cases are related by writers on midwifery in which a division of the hymen was requisite to facilitate parturition. In Meckel's Museum, at Halle, are preserved the external organs of a female in whom the hymen is perfect even after the birth of a seven-months child.

At the lower part of the orifice of the vagina there is imbedded in the loose tissue on either side a gland‡ of about the size of a small pea. Each has a long slender duct, which runs forwards and

* Such an one may be seen in the museum of the College, Phys. Series, No. 2843.

† See Burns' Midwifery.

‡ See Professor Tiedemann, Von den duverneyschen Drüsen des Weibs. Heidelberg, 1840.

opens on the inner side of the nymphæ. These glands, however, diminish in old age, and they are not invariably present in the young. In cases of virulent gonorrhœa they are apt to become diseased, and give rise to the formation of an abscess in the labium, which is very difficult to heal.

The description of the perinæal branches of the pudic vessels and nerves, given in the dissection of the male perineum, applies, *mutatis mutandis,* to the female, excepting that they are proportionably small, and that the artery which supplies the bulb of the urethra in the male is distributed round the orifice of the vagina in the female.

DISSECTION OF THE FEMALE PELVIS.

84. The learner is presumed to be familiar with the anatomy of the viscera in the male pelvis. Our present concern, therefore, is, to examine the organs superadded in the female, viz. the uterus and its appendages. We shall describe, first, their position in a general way ; and, secondly, their special anatomy.

On looking down into the female pelvis, we see the uterus interposed between the bladder in front and the rectum behind. From either side of the uterus there extends a broad fold of peritoneum to the side of the pelvis. These folds are called the *broad ligaments* of the uterus. On the posterior surface of the ligament are the ovaries, one on either side. They are completely covered by peritoneum, and suspended to the ligament by a small peritoneal fold. Along the upper part of the ligament we find between its layers a tube about four inches long, called the Fallopian tube. A better name for it is the oviduct, since its office is to convey the ovum from the ovary into the uterus. For this purpose, one end of it terminates in the uterus, while that nearer to the ovary expands into a wide mouth, furnished all round with prehensile fringes, which, like so many fingers, grasp the ovum as soon as it is ready to escape from the ovary. Lastly, there run up to the ovary, between the layers of the broad ligament, the spermatic, or rather the ovarian vessels and nerves which arise from the aorta in the lumbar

region, just as they do in the male, because the ovaries are originally formed in the loins.

a. If we look on the anterior surface of the broad ligament, we see on either side between its layers what is called the *round ligament* of the uterus. This is a cord which proceeds from the fundus of the uterus, through the inguinal canal, just like the spermatic cord in the male, and terminates in the mons veneris. Besides one or two small blood-vessels, it contains muscular fibres analogous to those of the uterus; these increase very much in pregnancy, so that, about the full term, the cord becomes nearly as thick as the end of the little finger.

85. SIDE VIEW OF THE FEMALE PELVIS.—After the removal of the innominate bone, as described at § 58, the vagina, rectum, and bladder should be moderately distended, and a catheter passed into the urethra. This done, let us first trace the reflections of the peritoneum.

86. *Reflections of the peritoneum.*—From the front of the rectum the peritoneum is reflected on to just a small part of the vagina, thus forming what is called the recto-vaginal pouch. From the vagina we trace the peritoneum over all the *back,* but only about half way down the *front* of the uterus; thence it is at once reflected over the posterior surface of the bladder, on to the wall of the abdomen.

We can easily understand, that in cases of ascites the water might distend the recto-vaginal pouch, and bulge into the vagina, and that it would be practicable to draw it off through this channel.*

87. *Pelvic fascia.*—To the description of the fascia already given in the dissection of the male pelvis (§ 59), nothing need here be added except that from the side of the pelvis it is reflected over the side of the vagina and the uterus as well as the bladder.

It is this fascia which in great measure supports and slings up the uterus in its proper level in the pelvis. Of its efficacy in this respect any one may be convinced by trying to pull down the

* In the Medical Communications, vol. i., a case is related in which four gallons of fluid were drawn off by tapping through the vagina. The woman immediately afterwards passed urine, which she could not do before. See also a case in Med. and Phys. Journal, vol. vii. p. 412.

uterus through the vagina. When, from any cause, the fascia becomes relaxed, there is consequently a greater liability to "prolapsus uteri."

Levator ani.—For the description of this muscle see § 62.

88. *Bladder.*—The female bladder is broader transversely, and, upon the whole, more capacious than the male. The vesical plexus of veins, as might be expected, is not so large, and there is no prostate gland. But the short urethra has a constrictor muscle, as in the male, and is supported in a similar manner by the pelvic fascia.

89. *Venous plexus.*—Though the veins round the neck of the bladder are comparatively small in the female, attention will be immediately attracted by the plexus of large veins which surround the vagina and the rectum. They seem out of all proportion to the size of the arteries. Their congestion in pregnancy sufficiently accounts for the dark colour of the vagina and the external organs, and the frequent occurrence of hemorrhoidal tumors.* It is necessary to remove these veins, with the cellular tissue in which they are embedded, before a clear view of the parts can be obtained; but the arteries should be carefully preserved for future examination.

90. *Urethra.*—Of the urethra we have already spoken at § 82. But in the side view of the parts we have the opportunity of observing how closely the bladder and urethra are connected to the upper wall of the vagina, and we can have no difficulty in understanding why, in cases of protracted delivery, it sometimes happens that the contiguous coats of the bladder and the vagina give way, and that there remains a fistulous communication between them, which continues to be a depending drain for the urine.

91. *Vagina.*—At the present stage of the dissection it is desirable to slit open the whole of the vagina along the side, and then we shall at once obtain a clear idea of the manner in which it embraces the lower end of the uterus, and of the extent to which

* During pregnancy, varicose tumors may form even in the vagina. In the Berlin. med. Zeitung 1840, No. 11, a case is related of a woman who, at the sixth month, bled to death from the bursting of a large vein in the vagina. Other cases of the kind are related by Siebold.

the neck of the uterus projects into it. This proceeding will also make more intelligible what is to be observed respecting the length, axis, and width of the vagina.

a. The length of the vagina, in an unimpregnated healthy adult, is, on an average, about 4½ inches. It may be more, or it may be less, the difference in each case depending upon the depth of the pelvis, the stature and age of the individual. Owing to the curved direction of the vagina, the anterior wall is about three-quarters of an inch shorter than the posterior. The vagina, however, is never so long but what we can, during life, feel the neck of the uterus projecting at the top of it; higher up, or lower down, according to circumstances. For instance, it is a little lower in the erect than in the recumbent position; again, in the early months of utero-gestation, the uterus descends a little into the vagina, so that this canal becomes shorter, but the reverse holds good when the uterus begins to rise out of the pelvis.

b. The axis of the vagina is slightly curved with the concavity upwards, and, for all practical purposes, may be said to correspond with the axis of the outlet of the pelvis; whereas the axis of the uterus corresponds with that of the brim of the pelvis.

c. The width of the vagina is not uniform throughout. The narrowest part is at the orifice: it is also a little constricted round the neck of the uterus. The widest part by far is about the middle; and, supposing a transverse section to be made through it in this situation, it would present the appearance of a broad horizontal fissure. If, therefore, we would insert the bivalve speculum upon anatomical principles, and consequently with the least amount of pain, the blades of the speculum should be vertical when we introduce them into the orifice of the vagina, and afterwards turned horizontally.

92. *Uterus.*—The uterus is the receptacle which receives the ovum, retains it for nine months so as to bring it to maturity, and then expels it by virtue of its muscular walls. Enough has been already said at § 84 of its situation and peritoneal connexions. We have now merely to notice, what was not very manifest before, namely, that its axis slants forwards, so that, upon the whole, the axis of the vagina and uterus describes a curve pretty nearly

parallel to the axis of the pelvis. The uterus, then, is so placed that it is ready to rise out of the pelvis into the abdomen after the embryo has attained a certain size. The wisdom of this provision becomes manifest in those cases where, from some accidental cause, the natural direction of the uterus has been altered, so that, instead of rising freely out of the pelvis, it becomes what is called retroverted; that is, the large end is tilted backwards against the sacrum, while the apex presses forwards against the neck of the bladder. It need hardly be said that such a malposition more or less obstructs the passage of both urine and fæces.

Respecting the size and shape of the uterus in the unimpregnated state, a better idea is conveyed by a single glance than by any description. Anatomists, however, generally liken it to what a pear would be if it were a little flattened; or, in other words, it is triangular with the angles rounded off. As to its average size, it is about three inches long, two inches broad, and one inch thick, at the upper part; but of course there is variety in this respect, arising from age, the effect of pregnancies, and other causes.

For convenience of description, we divide the organ into the fundus, the body, and the cervix. The term fundus is applied to that part which lies above the level of the Fallopian tubes. The body is the central part, while the cervix is the narrow part which projects into the vagina. It has already been mentioned that the vagina is very closely attached round the neck of the uterus, but we have now to observe that it is attached rather higher up behind than in front. The mouth of the uterus is at the apex of the neck. It is a transverse fissure, with a slightly prominent lip in front and behind, and, from its fancied resemblance to the mouth of a tench, it was called by the old anatomists the *os tincæ.*

Postponing for the present the examination of the interior of the vagina and the uterus, let us pass on to the vessels and nerves of these organs.

93. *Uterine* and *vaginal arteries.*—In addition to the branches given off in the male (described at § 70), each internal iliac artery, in the female, furnishes a branch to the uterus and another to the vagina.

a. The *uterine* artery proceeds from the anterior division of the

internal iliac towards the neck of the uterus, and then ascends very tortuously by the side of the uterus, giving off numerous branches to it. But the fundus of the uterus is chiefly supplied by branches from the ovarian arteries.

b. The *vaginal* artery ramifies along the side of the vagina, and sends branches to the lower part of the bladder and the rectum.

94. The *nerves* of the uterus are derived from the sacral nerves, and from the hypogastric plexus (§ 38, *a*). They accompany the blood-vessels to the neck of the uterus, and ascend with them along the sides of the organ.

The greater part of the nerves soon leave the vessels, and, subdividing, sink into the substance of the uterus, chiefly about its neck and the lower part of its body. But some very small filaments continue with the vessels, and form around them plexuses, upon which, according to the dissections of Mr. Beck*, minute ganglia are found.

95. The *absorbent* vessels of the uterus are very small in its unimpregnated state, but greatly increase in size when it is gravid. Those from the fundus and the ovaries proceed with the spermatic vessels to the lumbar glands; and this is the reason why the lumbar glands are sometimes affected in ovarian disease. Those from the body and the lower part of the uterus accompany the uterine artery, and join the glands in the pelvis; some, however, run along with the round ligament to the groin, and this is the reason why, in certain conditions of the uterus, the inguinal glands are apt to be affected.

96. *Structure of the vagina, uterus, ovaries, and oviducts.*— The uterus, vagina, ovaries, and oviducts, should now be collectively removed from the pelvis for the purpose of examining their internal structure. And first of the vagina.

97. Supposing the vagina to be laid open, we observe that it is lined by a mucous membrane of a pale rose colour. We observe, too, that the membrane is rough and furrowed especially near the orifice. A more or less prominent ridge runs along its anterior, and another along its posterior wall. From either side of these,

* Philosophical Transactions for 1846.

which are called the *columnæ rugarum,* there proceed a series of transverse ridges with rough jagged margins directed forwards. They are well marked in young females who are still virgins, but repeated parturition and increasing age gradually smooths them down. The use of the vaginal rugæ is to excite the sensibility of the glans in coition. They themselves also possess keen sensibility, for they are richly provided with papillæ.

The mucous membrane has a thick epithelial lining, and in the submucous tissue there is an abundant supply of muciparous glands. They increase in number and size towards the uterus, for the purpose, probably, of facilitating, by their secretion, the passage of the child. This secretion is thick, creamy, and slightly acid, and differs altogether from the secretion of the uterine glands, which is glairy, albuminous, and slightly alkaline. When poured out in excess, and somewhat altered in its character, it constitutes what is called leucorrhœa.

The chief strength of the vagina depends upon a fibro-cellular coat, which is about one-twelfth of an inch in thickness. If this coat be minutely injected, we find that it is made up almost entirely of the inosculations of blood-vessels. So much so that some anatomists regard it as erectile tissue.

98. Before the uterus is laid open, we should examine a little more fully the shape of that portion of the neck which projects into the vagina. First, then, it appears that the back part of the cervix projects into the vagina more than the front; but this merely arises from the vagina being attached higher up behind it. Supposing that the vagina were entirely cut away from the cervix, then the anterior lip of the uterus would appear to project a trifle more than the posterior. For this reason, as well as on account of the natural slope forwards of the uterus, the front lip is always felt first in an examination per vaginam.* The length, however, and the general appearance of the vaginal part of the cervix, varies according to the age of the individual, and it is also considerably altered by partu-

* This is the only way to reconcile the discrepancies one meets with in anatomical works, respecting the comparative length of the lips of the uterus. Kraus, Weber, Busch, and others, say the anterior is the longer. Mayer, Meckel, Quain, and others, the posterior.

rition. In the adult virgin it is smooth, plump, and round, and projects about half on inch; and its mouth is a small transverse fissure. But after the stretching which it undergoes in labour, one cannot wonder that it loses its plumpness, that the lips become flaccid and fissured, and the mouth larger than it was before.*

The uterus must now be laid open by a longitudinal incision, in order to examine its interior. The first thing that attracts attention is the great thickness of the walls. Before we come into the proper cavity in the body of the uterus, we have to slit up a long narrow channel which leads up into it through the neck. This channel is not of the same dimensions throughout, for it is dilated in the middle, and gradually narrows towards each end. The upper end, which leads into the body of the uterus, is called the *os internum,* and the lower end, which leads into the vagina, is called the *os externum.* The passage itself is generally called the cavity of the neck. It remains unchanged in pregnancy for some time after the cavity in the body has expanded, but of course gradually disappears with the increasing size of the embryo.

The shape of the cavity in the body of the uterus is triangular, with the apex towards the cervix. In a virgin uterus we observe that the cavity is remarkably small, and that its sides are convex; but in a uterus which has borne many children, we must expect to find that the cavity has lost the convexity of its sides, and that it has a little increased in capacity. Each angle at the base is somewhat produced, and leads to the minute opening of the oviduct. This production of the angles is noticed more or less in different females, and is the last indication of the two horns of the uterus in some orders of mammalia.

* Instances are recorded in which the neck of the uterus is preternaturally long. It has been known to project even as much as an inch and a half into the vagina. In such cases it gradually tapers, and terminates in a very narrow mouth. This is said to be one cause of sterility, and it is recommended either to dilate the mouth, or to cut off a portion of the neck. In support of this opinion, it is stated that Dupuytren was once consulted by a lady on account of barrenness: finding the neck of the uterus unusually elongated, he removed a portion of it, and in due time the lady became pregnant. (Hyrtl, Handbuch der top. Anatom.)

The interior of the uterus is perfectly smooth at the fundus, but just the reverse at the cervix. Here we remark that there is a central longitudinal ridge, both in front and behind, (just as we saw in the vagina,) and from these other closely set ridges curve off laterally, like the branches of a palm-tree. The old anatomists called it the *arbor vitæ*. The roughness produced by these ridges occasions an impression as though we were touching cartilage whenever a metallic sound is introduced into the uterus.

The neck of the uterus is provided with a number of small glands, of which the minute ducts open in the furrows between the ridges just now referred to. The secretion of these glands is glairy-looking, albuminous, and slightly alkaline, and sometimes comes away in such abundance as to be exceedingly troublesome. Soon after conception the secretion dries up so as to plug the mouth of the uterus, but shortly before and during parturition it is poured out in great quantity, in order to facilitate the passage of the child. It happens occasionally that one or more of the ducts of these glands become obstructed, and then dilate into small transparent vesicles, which gradually rise to the surface and burst. These were first described by Naboth,* and supposed to be true ova, and therefore they are commonly called *ovula Nabothi*.

The mucous membrane of the uterus is very much more delicate than that of the vagina, and is indeed scarcely separable from the subjacent tissue. The greater part of it is lined by a ciliated epithelium, but the epithelium of the cervix is tessellated like that of the vagina. The chief peculiarity, however, about the membrane is that every part of it is covered with minute follicles or tubes arranged at right angles to its surface. These tubes become greatly developed shortly after impregnation, and are presumed to take an active part in the formation of the *membrana decidua*.

The greater portion of the walls of the uterus consists of muscular fibres of the unstriped or involuntary kind, like that of the bladder or the alimentary canal. The texture of the fibres is so close, that it is exceedingly difficult to ascertain their precise arrangement; indeed, in the unimpregnated uterus it is useless to make the

* De sterilitate mulierum. Lips., 1707.

attempt, for they are comparatively atrophied. But in pregnancy, when all the component structures of the organ undergo simultaneous development, it may be observed that the fibres run either longitudinally or in concentric circles. The longitudinal fibres form a thick outside stratum, of which the direction is from the fundus to the neck of the uterus. The concentric circles form the deeper strata, and surround the orifices of the oviducts. Again, there are others which take a more oblique course, so that, upon the whole, their collective disposition is such as to exert equal pressure on all sides when called into operation.

At the same time, however, that they expel the fœtus, the muscular fibres perform another very important function; they close the large venous sinuses developed for its nutrition. Therefore, very little hemorrhage accompanies the expulsion of the placenta, provided always it have been attached to the fundus or the side of the uterus. But every one, on the other hand, knows the danger of what is called a placenta prævia. Here the placenta, planted as it were over the orifice of the uterus, is attached to a part of the organ which must of necessity expand during labour, and thus the reverse of what is common takes place, and every pain increases, instead of checking, the flooding. For the same reason it is plain that paralysis of the muscular fibres in immediate connexion with the placenta, be it where it may, is likely to be a source of serious hemorrhage in parturition.

99. The *Fallopian tubes or oviducts* are situated, one on each side, along the upper border of the broad ligament of the uterus. They are about four or five inches long. One end leads into the uterus, the other terminates in a wide funnel-shaped mouth, surrounded by a kind of fringe, like the opening in a pink flower. This is seen to the best advantage by floating it in water; and one or two of the fringes are generally found connected with the outer end of the ovary. If the subject be well injected, it is observed that they are richly supplied with blood-vessels from the spermatic artery. Now if we open the oviduct from the expanded end, and introduce a probe into it, we find that the tube runs very tortuously at first, and then straight into the uterus, gradually contracting in size all the way, so that the uterine orifice will scarcely admit a

bristle. Its mucous lining is gathered into longitudinal wavy folds, especially at the ovarian end, and with the microscope we detect that it is provided with a columnar ciliated epithelium. It must have long ago struck the attention that the free end of the oviduct communicates with the cavity of the peritoneum; and this is the only instance in the body where a mucous membrane is directly continuous with a serous one. It explains how it happens that the embryo may escape into the peritoneal cavity, though this be an extremely rare occurrence, because such ample provision has been made against it. It also explains what is said to have taken place, namely, the escape of the water in dropsy through the Fallopian tubes.

100. The *ovaries* are the most important parts of the female generative organs, since they contain the ova or the germs: for this reason they were called by Galen *testes muliebres*. We have already mentioned that they are, as it were, suspended to the back of the broad ligament of the uterus by a short peritoneal fold, which transmits their proper vessels and nerves; but besides this, they are connected to the uterus by a thin cord, called the ligament of the ovary. They are of an oblong form, with the long axis transverse, and are a little smaller than the testicles in size. In females who have not often menstruated, their surface is smooth and even; but in after life it becomes wrinkled and scarred by the repeated escape of the ova.

The ovary has nearly the same coverings as the testicle. There is first the serous coat, and beneath it the proper fibrous coat, or what is called the *tunica albuginea*. If a section be made through the ovary in order to examine the interior, we find that it contains a number of transparent vesicles, bedded in a soft fibrous-looking tissue, which is remarkably vascular when properly injected, and is called the *stroma* of the ovary.

The transparent vesicles just alluded to are the ovisacs, or the Graafian * vesicles. They vary in number from eight to twelve, and in size from that of a pin's head to a pea. The smallest are generally near the centre; but as they advance towards maturity,

* So called after De Graaf, a Dutch anatomist, who discovered them in 1672, and believed they were the true ova.

they gradually approach the surface, increasing at the same time in size. They contain a transparent albuminous fluid. If after puncturing one of the larger vesicles we receive its contents on a bit of glass, and then examine it under a microscope, we shall find suspended in it the true ovum or germ.* It is this minute body which, escaping from the Graafian vesicle on the surface of the ovary, is grasped by the Fallopian tube and conveyed into the uterus. The ruptured vesicle is converted soon afterwards into a yellowish-looking mass called a *corpus luteum,* which persists for a while, and eventually degenerates into a small fibrous cicatrix. The minute structure of the ovisac and the ovum belong to the province of physiology; the learner is therefore referred to special treatises on this subject.

The ramifications of the ovarian artery through the ovary are remarkable for their convolutions, and they run in parallel lines, just as they do in the testicle.

DISSECTION OF THE ABDOMINAL VISCERA.

Having already described the position and relations of the several abdominal viscera, we have now to examine their particular configuration and structure. Let us take first the liver.

101. Liver.—The liver is the largest gland in the body, and in an adult male generally weighs between four and five pounds. In shape we hardly know what to compare it to. All that can be said is, that it is thick and round towards the back, and that towards the front it gradually slopes to a thin border. Its surface is entirely covered by peritoneum, except a small part behind, which is connected to the diaphragm by cellular membrane, and just in the hollow for the gall bladder. On the upper surface of the liver, which we observe is convex, in adaptation to the arch of the diaphragm, there is nothing deserving of notice beyond the indication of the division of the organ into a right and a left lobe, the right being by far the larger. But if the liver be turned, so to speak, on

* This was first distinctly pointed out by Von Baer in 1827.

its back, we observe that the under surface is irregular, and that there are several fissures or channels in it for the passage of vessels. First, then, there is the *longitudinal fissure*, dividing the right from the left lobe; it contains the round ligament or the obliterated umbilical vein of the fœtus. The continuation of the longitudinal fissure to the posterior border of the liver contains the remains of what was in the fœtus the *ductus venosus,* and it is therefore called the fissure of the ductus venosus. Secondly, there is the *transverse fissure*, where the great vessels enter the liver. Thirdly, there is the hollow for the gall-bladder. And lastly, in the same line with this, there is the channel for the vena cava. Now the relative position of these parts may, perhaps, be best impressed on the memory by comparing them collectively to the letter H. The transverse fissure represents the cross-bar of the letter, the longitudinal fissure represents the left bar, while the gall-bladder and vena cava together make the right bar.

But this comparison to the letter H serves also to remind us of certain other parts or lobes of the liver, to which particular names have been given. For instance, in the upper square of the letter there is a tongue-like lobe, called the *lobulus Spigelii,* and this is connected to the right lobe by a shelving ridge or tail, called the *lobulus caudatus.* Again, the area of the lower square is called the *lobulus quadratus.*

Lastly, the right lobe presents, generally speaking, a shallow depression, adapted to the right kidney.

The liver has a thin fibro-cellular coat or capsule, which can be best seen on those parts of it not covered by peritoneum. So far it is like all other glandular organs. But it does not appear that the capsule sends down partitions so as to form anything like a framework for the interior of the organ. At any rate, nothing of the kind is observed with the naked eye when a portion of the capsule is stripped from the surface. Whether there be a cellular framework or not between the lobules, it is certain that it must be exceedingly delicate, and this is the reason why the liver is so liable to be lacerated by external violence, or even by the action of the abdominal muscles.

Minute structure of the liver.—All that we can hope to do here

without the aid of injected specimens and correct diagrams is to give a general outline of the plan upon which the organ is constructed, according to the accepted doctrine of the present day.

The liver is composed of the ramifications of the portal vein and the hepatic artery which carry the blood *to* it, and secrete the bile, of the ramifications of the excretory or hepatic duct, of the ramifications of the hepatic veins, which return the blood *from* it, and of course of nerves and absorbents. Now, it will greatly facilitate the understanding of the subject, if we bear in mind,—1, that the three first sets of vessels (namely, the portal vein, hepatic artery, and hepatic duct) ramify together from first to last. They are enclosed, too, in a kind of sheath of loose fibro-cellular tissue, commonly called *Glisson's capsule,* which enters with them at the transverse fissure; and this explains why, when cut transversely, the portal vein does not gape, but partially collapses; 2, that the hepatic veins run from first to last by themselves, and eventually terminate by several wide orifices in the vena cava as it passes through the liver. These, having no cellular sheath, always appear, on transverse section, with open mouths.

Now come the questions, What is the distribution of the minute branches of the portal vein, and what that of the hepatic vein? These questions are determined by injecting each set of vessels simultaneously with a fluid of a different colour,—say a blue fluid for the portal vein, and a yellow for the hepatic. Afterwards, sections in different directions must be made, and examined under the microscope.

In answer to the first question, it may be stated that the minute ramifications of the portal veins map out the substance of the liver into small spaces, which are called *the lobules.** These can be seen plainly enough, even with the naked eye, and they have a different shape according to the direction in which they are cut; for instance, on the surface of the liver, or which comes to the same thing, in a transverse section, they look like mosaic pavement; but in the perpendicular section they somewhat resemble a club or an oak leaf. From the circumference of the lobule, the capillaries of

* The current name for these veins is "inter-lobular."

the portal vein penetrate into its area, minutely inosculating with each other, and then freely communicate towards the middle of the lobule with the radicles of the hepatic vein.

The second question may be answered thus:—The radicles of the hepatic vein commence within the lobule by free inosculations with those of the portal vein, and converge towards a single vein which runs down the centre of the lobule. This central vein* opens at once into an hepatic vein,† larger or smaller as the case may be, upon which the lobule is, so to speak, sessile. Thus, then, on a perpendicular section, we should see the hepatic veins running into the central vein, like the side veins of an oak leaf do into the midrib; while, on a transverse section, they would present a starred appearance.

And now a word or two respecting the ultimate ramifications of the hepatic artery and the hepatic duct.

The *hepatic artery*, entering the liver at the transverse fissure, divides and subdivides, as we have already said, with the portal vein, and ultimately ramifies with it between the lobules. A few only of the arterial capillaries enter the lobules. The chief office of the artery would appear to be, to supply the coats of the other vessels of the liver,—in other words, the machinery of the organ.

The *hepatic ducts* commence within the lobules by numerous ramifications, which form a close network near the circumference of each lobule. From this network branches proceed on all sides, and accompany the portal veins.

Great doubt still exists as to how the ducts begin. Some say they commence by blind extremities; others by simple channels between the hepatic cells. Be this as it may, their radicles are surrounded by minute cells, which are in point of fact the essential organs which secrete the bile.

Hepatic cells.—The interior of each lobule, that is, all the space left between the several vessels, is filled by the hepatic cells. These are nucleated, and have a mean diameter of about $\frac{1}{1000}$th of an inch. In some cases they contain fat globules, and when these accumulate

* The central vein is commonly called intra-lobular.

† The hepatic vein which receives the central vein is called sub-lobular.

in large quantities, they constitute what is called a fatty liver. The office of the cells is to separate the bile from the blood, in some way which we do not understand, and when filled with bile, they burst, or otherwise discharge themselves into the bile ducts.

Such, in outline, is the minute anatomy of the liver. If it be rightly understood, we can have no difficulty in determining, in a section of the organ, whether the portal or the hepatic venous system be congested.*

99. GALL BLADDER.—The gall bladder is confined by the peritoneum in a slight depression on the under surface of the right lobe of the liver. (See § 19 *b.*) We observe that it is shaped like a pear. Its size varies a little in different subjects; generally speaking, it is about four inches long, and will hold about 1½ oz. of fluid. Its narrow end, or neck, makes a bend downwards, and terminates in a duct, called the cystic, which, after a course of about one inch, joins the hepatic. The common duct, formed by their union, is about three or four inches long, and we remember that it opens into the back of the descending part of the duodenum, after running very obliquely through the coats of the bowel.

Exclusive of its partial peritoneal covering, the gall-bladder has only two coats. The outer one, called the cellular, consists of dense shining fibres, interlacing in all directions:† the other is the mucous coat.

The *mucous* coat is generally tinged yellow by the bile. The chief peculiarity about it is that it is gathered into a number of ridges which make it like a honeycomb on a small scale. It is covered by a columnar epithelium, which secretes an abundance of viscid mucous. Furthermore, we have to observe that at the bend of the neck of the gall-bladder, both its coats project very much into the interior, making the opening considerably narrower than it appears to be outside. Lastly, in the cystic duct, the mucous membrane presents a series of folds, so arranged, one after the

* For further information on the subject, see the original observations of Kiernan in the Philosoph. Trans. for 1833.

† In some animals, *e. g.*, the horse and the cow, the gall-bladder possesses a few non-striped muscular fibres.

other, as to form a complete spiral valve. The use of this probably is to prevent the too rapid flow of the bile.

100. Pancreas.—This gland is situated at the back of the abdomen, behind the stomach, and nearly opposite the first lumbar vertebra. Its form and connections have been described at § 29. Its minute structure resembles that of the other salivary glands—that is, it consists of lobes; and these are subdivided into lobules, all being connected together by cellular tissue. Each lobule consists of the ramifications of a duct. These, when examined by the microscope, are found to terminate in closed vesicles, which are completely covered by the capillary arteries.

The main duct * of the pancreas runs transversely through the centre of the gland, rather nearer to the front than the back, and to the lower than the upper surface, and, as it receives tributary ducts from the several lobes, gradually increases in size. Its walls are remarkably thin. By introducing a probe into it, we find that it opens very obliquely into the inner and back part of the descending portion of the duodenum, not far from the orifice of the bile duct.

101. Spleen.—The spleen is a very vascular spongy organ, varying in size according to the quantity of blood in it, and fluctuating in weight, consistently with health, between 5 and 12 oz. Under ordinary circumstances it is of a reddish blue colour, owing to the large amount of blood in it. But the proper colour of the substance of the spleen is a yellowish grey. This is well seen in cases of cholera, where the organ is bloodless and collapsed; it is also proved by injecting the splenic artery with water, which returns freely by the veins, and washes out all the blood.

Its shape is elliptical, and in its natural position it is so placed that the long axis is nearly vertical. The outer side, adapted to the diaphragm and ribs, is convex, while the inner side, adapted to the great end of the stomach, is concave. We observe that the blood-vessels enter the concave side by several ramifications, corresponding to the primordial lobes of the organ.

In addition to its peritoneal coat, the spleen has a proper fibrous

* Called the canal of Wirsung, after a Bavarian anatomist, who discovered it in the human subject in 1643.

capsule, which must of necessity be elastic to accommodate itself to the varying size of the organ. This capsule not only covers the outside of it, but also sends down into the interior numerous threads, which cross each other in various directions, and form a kind of network, dividing the spleen into so many mutually communicating chambers. Moreover, it is interesting to observe that at the points where the bands cross they are secured by a small white knot. Besides constituting the general framework of the organ, the capsule provides the vessels with sheaths which support them throughout their ramifications in the interior.

Now the splenic chambers are filled by what is called the pulp of the spleen. This is a soft reddish brown substance, which may be easily scraped off with the knife. If a portion of it be examined under the microscope, we find that it consists entirely of gland cells of a pale yellow colour, and somewhat smaller than the corpuscles of the blood. Here and there, however, in the pulp are found other larger cells, of a white colour and perfectly spherical form.* Attention was first directed to them by Malpighi, and they have therefore been called after him the "Malpighian bodies." They are not free like the smaller cells, but attached, each by a slender pedicle, to one of the threads. The pedicle contains a small artery, which ramifies over the surface of the cell, and then terminates in a brush of capillaries which spread out in the pulp. The interior of the cell is filled with a clear fluid and a multitude of smaller cells, so that in point of fact it is but a closed sac, containing secreting elements.

With regard to the manner in which the blood-vessels are distributed, we observe that the splenic artery enters the spleen by several branches, which ramify throughout the organ supported by sheaths derived from the capsule.† These ramifiations, however,

* In the human spleen they are about $\frac{1}{80}$ inch in diameter. But it is useless to look for them unless the subject be exceedingly fresh, for they soon soften and melt in the pulp. It is better, therefore, to examine them in the spleen of a sheep or bullock, in which animals they are about $\frac{1}{40}$ inch in diameter.

† The ramifications of the splenic artery may be well seen by washing away the pulp, and floating the then flocculent-looking spleen in water.

do not communicate with each other, for, if injection be thrown separately into one branch, it fills part only of the spleen. The smallest ramifications spread out in a brush-like manner through the pulp, and then lead into the veins. Lastly, the veins themselves form in the pulp a minute network. But this part of the circulation is not yet thoroughly made out.

Thus, then, it appears that the spleen is essentially a great blood gland, and that it consists of chambers filled with secreting gland cells of various size, between which there ramify minute arteries and veins. It is presumed that the cells in some way or other purify or elaborate the blood; but the precise function of the organ is unknown.

102. KIDNEY.—With the form and colour of the kidney every one is familiar. Its weight is, on an average, about five ounces in the male, rather less in the female, and in the great majority of cases the left is heavier than the right.

It is surrounded by a thin but firm capsule, which adheres by minute vessels to its surface, but does not penetrate into its interior. For this reason the capsule can, under ordinary circumstances, be readily stripped off; if not, the presumption is, that its preternatural adhesion is the result of disease.

The best way to display the anatomy of the kidney is to make a longitudinal section through it. We then observe two seemingly distinct structures. The more superficial structure, called the *cortical*, is of a uniform red colour, because the blood-vessels are most copiously distributed in it; it is, in fact, the secreting part of the organ. The deeper structure, called the *medullary*, consists of the minute tubes which carry off the urine. We observe that these tubes, converging from the cortical part, are collected into from ten to sixteen pyramidal bundles; their nipple-like points, (termed *papillæ*) consisting of the terminations of a great number of coalesced tubes, project into the pelvis of the kidney, or the common receptacle of the secretion, from all parts of the organ.*

* Each pyramid represents what was, in the early stage of the kidney's growth, a distinct and independent lobe. In the human subject the lobes gradually coalesce, and no trace of their primordial state remains, except the

The pelvis, or common receptacle of the kidney, is but the dilated beginning of the ureter. It is somewhat funnel-shaped, and its broad part divides into two principal tubes, which again branch out and form from eight to twelve cup-like excavations (called the *calices*). Into each of these calices one, or sometimes two, papillæ are seen projecting.

The renal artery proceeds to the kidney between the vein in front, and the ureter behind, and divides into five or six branches, which, again subdividing, make their way between the pyramids to the cortical substance. Their minute ramifications terminate in one of two ways,—either in plexuses round the tubes, or in what are called the Malpighian bodies.

If we examine with a microscope a portion of a minutely injected kidney, we observe that the cortical substance is full of red round knots, formed by the coils of minute blood-vessels: these are the *Malpighian* bodies.* They are, on an average, about $\frac{1}{130}$th of an inch in diameter. According to the recent researches of Mr. Bowman,† each is loosely surrounded by a flask-like capsule, formed by the dilatation of the beginning of a urinary tube. The continuation of the tube passes off from that part of the capsule most remote from where the artery entered, and, after making many convolutions, finally enters one of the pyramids, and so discharges its contents. The vein returning the blood from the Malpighian body leaves the capsule close to where the artery entered, and then, instead of going out of the kidney, as in other organs, forms a capillary plexus round the convolutions of the tube. The special purpose of this plexus appears to be the secretion of the solid matter of the urine; while the Malpighian body filters, so to speak, the watery part of the urine into the capsule, and washes the more solid part down the tube.‡

pyramidal arrangement of the tubes. But in the kidneys of the lower mammalia, of birds and reptiles, the lobes are permanently separate.

* So named after Malpighi, a celebrated Italian anatomist who lived during the middle and latter part of the seventeenth century.

† See his paper in the Philosoph. Trans. for 1842, Part I.

‡ That the vessel leaving the Malpighian body is a vein, and that a constituent part of the urine is secreted by venous blood, is inferred from two

Lastly, the minute urinary tubes are lined by a ciliated epithelium: the epithelium of the pelvis of the kidney, and of the ureter, is tesselated.

103. Supra-renal capsule.—This body is situated at the top of the kidney, and in shape resembles a cocked hat. It is surrounded by a thin covering, which sends down partitions into the interior through furrows observed on the surface.

If a perpendicular section be made through it, we find that it consists of a pretty firm exterior or cortical part, and of an interior soft pulpy substance. The cortical portion is of a yellow colour, and forms the principal part of the organ. When examined with the high powers of the microscope, it is found to be composed of independent closed tubes, about $\frac{1}{700}$th of an inch in diameter, arranged perpendicular to the surface, and covered by the minute ramifications of the arteries. The tubes contain a few nucleated cells, but chiefly minute granules. The central part is of a very dark brown colour, and so soft in texture that one might mistake it for a cavity. It appears to consist almost entirely of a plexus of minute veins.*

In early fœtal life the supra-renal capsules are comparatively of large size, surpassing the true kidneys in dimensions. They afterwards diminish in size, and become subordinate organs. But their precise function is unknown.

104. Stomach and intestines.—The alimentary canal is composed of three coats, differing in structure, and connected together by cellular tissue. First, there is a *serous* or peritoneal coat, which has been sufficiently described at § 22. Secondly, under the serous is a *muscular* coat, upon which the chief strength of the bowel depends. It consists of two distinct strata of fibres; the outer stratum is longitudinal, the inner circular. This arrangement not only makes the bowel all the stronger, but also regulates its peristaltic action; for the longitudinal fibres, by their contrac-

reasons: 1, from the analogous case of the vena portæ, out of which the bile is elaborated in the liver; 2, from the fact that in reptiles the urine is secreted from venous blood.

* Consult "A Physiological Essay on the Thymus Gland," by Simon. London, 1845.

tion, tend to shorten and straighten the tube, so that the circular fibres contract upon and propel the contents of it to greater advantage. Lastly, there is the internal or *mucous* lining. This, we shall find, is the most complicated of the three, for it presents different characters in different parts, according to the functions which it has to perform.

105. *Stomach.*—The stomach should be distended with air, that we may form some idea of its size and shape. Its size will naturally vary in different instances, according to the habits of the individual; and its shape, for want of a better comparison, is likened to the bag of a bag-pipe. Respecting the nomenclature of its different parts, we may just mention that the larger part of the organ, near which the food enters, is called indifferently the œsophageal or the cardiac end; while the smaller part, at which the food passes out, is termed the pyloric end. Again, we speak of the upper margin, or the lesser curve; of the lower margin, or the greater curve; of the anterior and the posterior surface, &c.

a. Of the *muscular* coat of the stomach nothing need be said, except that its fibres take a longitudinal and a circular direction; but they are not so precisely regular as those of the rest of the alimentary canal. The longitudinal fibres are most marked at the curves, and the circular fibres at the pylorus, where they form a powerful sphincter. Here and there, however, especially at the sides, a number of fibres run very obliquely, not unlike those of the bladder. If any of these muscular fibres be examined with the high powers of a microscope, we find that they belong to the involuntary or non-striped variety. The same observation applies to the muscular coat of the intestines generally.

b. When the stomach is laid open for the purpose of examining its interior, we observe that the *mucous membrane* is of a pale colour, and gathered into longitudinal folds; but these disappear when the stomach is full. If a piece of the membrane be cut away, there is seen beneath it a very distinct stratum of fibro-cellular tissue, which is sometimes called the submucous coat. The object of it is to permit the muscular and mucous coats to move freely on each other, and it also serves as a kind of bed, in which the blood-vessels ramify very minutely before they enter the mucous mem-

brane. This observation applies not only to the mucous membrane of the stomach, but to that of the alimentary canal generally.

c. We come next to examine that which is the essential characteristic of the mucous membrane of the stomach,—namely, the apparatus for the secretion of the gastric fluid. If a portion of well-injected mucous membrane be taken from the stomach of any mammalian animal, and examined with one of the low powers of a microscope, we observe that the capillary blood-vessels present an hexagonal arrangement, and that they map the surface into so many little pits, giving it rather a honeycomb appearance. The pits are, on an average, $\frac{1}{100}$th part of an inch in diameter. At the bottom of them we see a number of minute pores. These are the orifices of the gastric tubes. On a perpendicular section, we find that the tubes are arranged in parallel bundles at right angles to the surface, and that they terminate in blind and rather sacculated ends, which are set in the submucous tissue. In point of fact, the entire thickness of the mucous membrane is made up of these tubular glands. It is presumed that, during digestion, they generate a number of cells containing the digestive fluid. As fast as they are formed the cells pass into the stomach, discharge their contents among the food, and disappear.

d. At the same time that we examine the arrangement of the tubes of the stomach, we ought to observe how richly they are supplied with blood. The arteries form a stratum of minute inosculations in the submucous tissue, in which the bottoms of the tubes are set; from this stratum the vessels run up between the tubes to the surface of the stomach, where they again inosculate, so as to form the hexagonal spaces mentioned in the preceding paragraph.

Lastly, the mucous membrane of the stomach, and also of the interior of the tubes, is lined by a columnar epithelium. But it is exceedingly thin and delicate, and can only be seen in the stomach of an animal recently killed.

106. *Small intestines.*—The small intestines, consisting of the duodenum, jejunum, and ilium, form a tube about twenty feet long. So far as concerns their external character, we need only remark that the duodenum and jejunum are much more vascular than the

ilium, and that they may feel much thicker in consequence of the peculiar arrangement of their mucous membrane. The reason of this difference is, that the upper part of the small intestine is more concerned in digestion than the lower. Their peritoneal and muscular coats are essentially the same throughout; but the mucous coat requires especial notice.

a. When the small intestines are cut open, beginning at the upper end, the first thing that attracts notice is that the mucous membrane is arranged in a number of close folds, or plaits, technically called the *valvulæ conniventes.* Now these differ from other folds in the alimentary canal, *e. g.* in the œsophagus and stomach, in that they are not obliterated when the tube is distended. Each fold extends about one-half or two-thirds round the intestine; but they are not all of equal size. It will be observed that they do not commence at the pylorus, but immediately below the openings of the biliary and pancreatic ducts, and that they are the most largely developed in the duodenum and the upper part of the jejunum. Below this part of the tube they gradually decrease in size, and become less closely packed, till they finally disappear near the middle of the ilium. The use of the valvulæ conniventes is to increase the extent of surface for the absorption of the chyle, and also for secretion.

b. Let us next examine what are called the *villi* of the small intestine, and afterwards the different kinds of glands with which it is provided.

If a portion of the small intestine be carefully washed and placed in water, we observe that the surface of the mucous membrane is just like the soft fur or pile upon velvet. This appearance is produced by the villi. Now these are nothing more than extremely vascular projections of the mucous membrane, about a fourth of a line in length, and so close to each other that a square line contains from forty to fifty of them. Their size, however, and their number bear a direct ratio to that of the valvulæ conniventes. Their structure is exceedingly simple. In a well-injected specimen we find that each is furnished with an artery which forms a beautiful network of inosculations all over it, and then returns its blood by a single vein. Each, too, contains in its interior a lacteal or absorb-

ing vessel, which commences, not, as was formerly supposed, by an open mouth, but by a closed end near the summit of the villus. Lastly, they are covered by a layer of cylindrical epithelium, like all the rest of the intestinal mucous membrane. To see this we must take the specimen from a fasting animal; for the epithelium is thrown off during digestion, so that the naked villus comes in contact with the food.

c. There are three kinds of *glands** in the small intestines, named, after their respective discoverers, the glands of Lieberkühn, Brunn, and Peyer. The first are distributed over the whole tract of the mucous membrane; the two last only over particular parts.

d. The *glands of Lieberkühn*† are simply minute tubes, with blind ends, very thickly distributed over both the small and the large intestines. With a microscope,—for they are invisible to the naked eye,—we see their orifices between the villi, like so many minute dots, as if the surface had been pricked with needles. In a vertical section we should observe their depth, and that they are lined by a columnar epithelium.

e. The *glands of Brunn*‡ are found only in the duodenum. They are just visible to the naked eye, and may be seen to the best advantage by removing the muscular coat. Their structure exactly resembles the pancreas, on a diminutive scale.

f. The *glands of Peyer*§ abound most in the ileum. Their chief peculiarity is, that they are arranged in groups on that part of the intestine most distant from the attachment of the mesentery. These groups are generally from one to two inches long, and of an oval form; but it should be observed that they increase both in size and number as we approach the lower part of the ilium. If a group be examined by dissecting away the muscular coat, we find

* A satisfactory examination of the intestinal glands can be made only in specimens quite recent, taken from young persons who have died suddenly, or from a rapidly fatal disease.

† J. N. Lieberkühn, Diss. de fabric. et actione villorum intestin. tenuium, 1782.

‡ J. C. Brunn, Gland. duoden. seu pancreas secundarium, 1715.

§ Peyer, De glandulis intestinorum, 1682.—But these glands were described by our countryman, Nehemiah Grew, in 1681.

that the glands are imbedded in the submucous tissue, that they are rather opaque, about three-fourths of a line in diameter, and in shape not unlike a Florence flask. They have no discoverable orifices. When full and ripe, they come to the surface, burst, discharge their contents, and die,—for what purpose is not precisely known. These are the glands which are so liable to be ulcerated in fever.

But the glands of Peyer are not confined to the ilium. Glands in all respects like them, except that they are *solitary,* are found scattered in all parts of the small intestine, and also in the large.

107. *Large intestine.*—The principal external characters of the large intestine are, that it is pouched or sacculated, and that it has, attached to it, little pendulous portions of fat covered by peritoneum, called *appendices epiploicæ.* Now the pouches are obviously produced by a shortening of the longitudinal muscular fibres, and by their being collected into three bands, about half an inch wide, and nearly equidistant from each other. One of these bands corresponds with the attached part of the circumference of the bowel, another with the front part, and the third with what may be called its concavity. If at any given part the three bands be divided, the pouches immediately disappear.

The rectum differs from the rest of the large intestine in that its longitudinal muscular fibres are not collected into bands, but distributed equally over its whole circumference. Moreover, both the longitudinal and circular fibres are of considerable strength, like those of the œsophagus, as one might expect from the particular functions which these parts of the alimentary canal have to perform. Lastly, for one inch and a half, or thereabouts, above the anus, the circular fibres are remarkably developed, and constitute what is termed the internal *sphincter ani.*

a. The mucous membrane of the large intestine differs materially from that of the small. It is altogether more simple. There are no valvulæ conniventes nor villi; but there are plenty of Lieberkühn's glands, and plenty also of the flask-like solitary glands* like those in the ileum. As far as regards the arrangement of the

* The solitary glands are more abundant in the cæcum and in the appendix vermiformis than in any other part of the alimentary canal.

blood-vessels, it deserves to be remarked that a piece of well-injected mucous membrane from the large intestine presents the same hexagonal arrangement on the surface as that of the stomach ; but the gastric glands are absent.

b. Ilio-cæcal valve.—At the junction of the small with the large intestine the mucous membrane is folded in such a manner as to form a valve ; but it is not a perfect one, as is proved by pouring water into the large intestine, or by the occasional vomiting of injections. The arrangement of the valve is best examined in a dried preparation. We then observe that the opening is a transverse fissure, and that there are two flaps to it. The upper one is nearly perpendicular, while the lower is nearly horizontal ;—but a single glance gives a better idea of its construction than any description.

c. Folds in the rectum. — In many subjects we observe that transverse or oblique folds of the mucous membrane project into the rectum. We cannot see them to advantage unless the bowel be hardened by alcohol in its natural position. Three, more prominent than the rest, and half an inch, or thereabouts, in width, were first pointed out by Mr. Housten.* One projects from the upper part of the rectum, opposite the prostate gland ; another is situated higher up, on the side of the bowel ; while the third is still higher. When thickened or ulcerated, these folds are apt to occasion pain or even obstruction in defæcation.

* Dublin Hospital Reports, vol. v.

THE DISSECTION OF THE THIGH.

1. An incision should be made along the bend of the thigh, from the spine of the ilium to that of the pubes; another, from the middle of the first, perpendicularly downwards for about six inches. We do not propose to commence, at once, the general dissection of the thigh, but to examine the special anatomy of the inguinal region.

2. *Superficial fascia.*— Reflecting the skin, we expose the subcutaneous adipose and cellular structure, of which the thickness varies according to the condition of the body. It is commonly described as being divisible into layers. The truth is, that any one who is dexterous with the scalpel can make as many layers as he pleases. Imbedded in it we find the superficial femoral absorbent glands, and numerous cutaneous vessels which ramify in different directions. One ascends over the surface of the abdomen, another towards the pubes, and a third towards the ilium; they are named accordingly the superficial *epigastric,* the superficial *pudic,* and the superficial *circumflexa ilii* arteries. All of them come from the femoral, and each is accompanied by one, or sometimes by two veins, which empty themselves, either directly into the femoral, or into the great cutaneous vein of the thigh, called the saphena. These superficial glands and vessels it should be our first object to display.

3. *Femoral glands.*—These are easily recognized, by their reddish-brown colour, imbedded in the subcutaneous tissue at the upper and front part of the thigh. They are generally situated close to a vein, but more especially along the outer side of the saphena. They vary in number and size, and are commonly oval, with the long axis vertical. In a well-injected subject we observe how freely they are supplied with blood-vessels; and this accounts for the rapidity with which they sometimes enlarge. They transmit the absorbents from nearly all parts of the lower extremity. In

ordinary cases these vessels escape observation, unless specially sought after; but in dropsical bodies they become distended, and look like transparent tubes. They all ascend through the femoral ring into the abdomen, and after traversing other glands there, eventually empty themselves into the thoracic duct.

The glands mentioned in the preceding paragraph are all superficial. There are others more deeply seated close to the great vessels of the thigh: these, however, are much smaller, rarely exceed three or four in number, and sometimes cannot be found.

4. Respecting the *superficial epigastric, pudic,** and *circumflexa ilii* arteries, we have only to observe that their particular ramifications vary in each case, though their general distribution is nearly the same in all. In a surgical point of view they are of importance, since they are exposed to injury in opening abscesses in these parts; and the pudic, more especially, in the operation for femoral hernia. Arising, as they do, directly from so large an artery as the femoral, we cannot wonder if they sometimes bleed profusely; for it is an admitted fact, that when even a small branch, coming directly from a principal artery, is divided near its origin, it will sometimes pour out as much blood as if an opening were punched out of the trunk as large as the area of its divided branch.†

5. *Saphena vein.*—This is the chief subcutaneous vein of the lower limb. Its roots, arising on the inner side of the foot, unite into a single trunk, which ascends over the inner ankle, along the inner side of the leg and knee, and then along the inner and front part of the thigh, where we now see it joining the femoral vein immediately below the crural arch. In this remarkably long

* The pudic branch referred to in the text is quite superficial. There is generally another, which runs for some distance beneath the muscular fascia covering the pectineus, and is also distributed to the scrotum or the labium pudendi, as the case may be.

† Mr. Liston had occasion to tie the external iliac artery for a supposed injury (by a pistol-ball) to the femoral. It was discovered, after the death of the patient, that the ball had injured only one of the superficial branches of the femoral, about an inch from its origin.—See his paper in the Med.-Chir. Trans. vol. xxix., 1846.

course it receives several tributary veins, some of which are often as large as itself; and, just before its termination, it is joined by the superficial veins of the groin already alluded to. Like all subcutaneous veins, it is provided at intervals with valves, to support the column of the blood; and when these happen, from any cause, to be inefficient, the vein is apt to become enlarged and tortuous.

Postponing for the present the description of the general muscular fascia of the thigh, called the *fascia lata,* let us now examine the opening in it which transmits the saphena vein.

6. *Saphenous opening in the fascia lata.*—Immediately below the crural arch there is an opening in the muscular fascia of the thigh, which, as it gives passage to the saphena vein, is appropriately called "the saphenous." Now since this opening is one of the parts concerned in the anatomy of femoral hernia, the mode in which it is formed, its shape, dimensions, and borders,— n fact, every thing connected with it,—is described by anatomical writers with very minute precision. He who dissects these parts for the first time can hardly expect to make them out satisfactorily, still less to make his dissection tally with the description usually given. The fact is, that this saphenous opening is a sort of anatomical puzzle, complicated at first sight, but simple enough when fairly explained.

After the subcutaneous structure has been carefully removed, and the saphena vein traced to where the opening in the fascia is said to be, the learner will probably be perplexed at not finding it; and very naturally, for it is not visible. The reason of this is, that the deep layer of the subcutaneous tissue, as it passes over the opening, is intimately connected to its margin, so that this does not appear unless the above-mentioned layer be cut away from it. Now since this layer closes the opening, we can have no difficulty in understanding that it must be perforated by all the vessels passing through the opening: hence it has received the name of *cribriform fascia.* Let it be understood that this is no superadded membrane, but only part of the general subcutaneous structure. When a femoral hernia protrudes at the saphenous opening, this cribriform fascia necessarily becomes one of its coverings.

The cribriform fascia must, therefore, be cut away before we can

clearly make out all that relates to the opening in question. We have to observe that the opening is situated just below the crural arch, not far from the pubes; and that it is of a somewhat oval form, with the long axis vertical, and about one and a half or two inches long. In respect to its borders, we find that on the inner or pubic side it is not at all defined, for here the muscular fascia ascends uninterruptedly under the femoral vessels, and is continuous with the iliac fascia of the pelvis.* But the outer or iliac border is defined clearly enough. This lies in front of the femoral vessels, and is crescent-shaped, with the concavity towards the pubes. Now, if we trace the lower horn of the crescent, we find that it curves up below the saphena vein, and is lost in the fascia on the inner side of the opening. On the other hand, if we follow the upper horn,† we see that it arches over the femoral vein, and is continued uninterruptedly into Gimbernat's ligament, or into that part of the crural arch which is inserted into the crest of the pubes. The upper horn deserves especial attention, because it forms the upper boundary of the aperture through which a femoral hernia takes place; and, having a great deal to do with the constriction of the rupture, is often divided for its relief. This may be easily ascertained by gently introducing the little finger under the crural arch, on the inner side of the femoral vein,—in other words, into the femoral ring. We then perceive how much the upper horn of the crescent would girt the neck of a hernia, and likewise that its tension is greatly influenced by the position of the limb; for if the thigh be bent and brought over to the other side, the tension of all the parts concerned is materially lessened. This explains the position in which a surgeon places the leg before he attempts to reduce a rupture.‡

* On the inner side of the femoral vessels, the pubic portion of the fascia is attached to the crest of the pubes.

† This upper horn is sometimes called "Hey's ligament," after the surgeon who first drew attention to it: Observations in Surgery, by W. Hey, F.R.S. London, 1810.

‡ We must always bear in mind, that though the crural arch and the adjacent fasciæ have received particular names, they are not, on that account, dis-

ANATOMY OF TH: PARTS CONCERNED IN FEMORAL HERNIA.

7. The anatomy of the parts concerned in femoral hernia cannot be thoroughly understood without the assistance of special dissections; indeed, one cannot reasonably expect to make oneself master of the subject, if it be taken in hand merely as something to be investigated by the way in the dissection of the thigh. The following demonstration, therefore, takes for granted that we have the opportunity of seeing the parts, not only on their femoral aspect, but also on their abdominal side.

We propose to treat the different parts of our subject in the following order:—

a. The formation of the crural arch.
b. The arrangement of the parts which pass under the arch.
c. The femoral aperture or ring.
d. The so-called sheath of the vessels.
e. The practical application of the subject.

8. *Crural arch.*—The lower border of the aponeurosis of the external oblique muscle extends from the spine of the ilium to the spine of the pubes, and forms, over the bony excavation beneath, what is appropriately called the "crural arch." A glance at the relative position of its attachments is sufficient to show that the direction of the arch is oblique; besides which, in consequence of its intimate connection with the muscular fascia of the thigh, the line of the arch describes a gentle curve with the convexity downwards. The pubic insertion of the arch is a point which we must thoroughly understand. Not only is the arch attached to the spine of the pubes, but also for some distance along the ridge of this bone, which forms the brim of the pelvis. This additional attachment, called after its discoverer *Gimbernat's ligament*,* is of material importance, for it is generally the seat of the stricture in hernia.

tinct and separate, but all are intimately connected, and portions merely of one continuous expansion. Thus all the parts are kept in a condition of mutual tension, which depends very much on the position of the thigh.

* Don Antonio de Gimbernat was a Spanish surgeon, who published, in 1793, "A New Method of Operating for the Femoral Hernia," Madrid.

The best view of Gimbernat's ligament is obtained from within the abdomen. All that is necessary is to remove the peritoneum. We then observe that it is triangular, with the apex at the pubes; and that the base, directed outwards, is rather curved than otherwise, and feels sharp and wiry. Its breadth is, generally speaking, from three-quarters of an inch to one inch; but it varies in different subjects, and is always broader in the male than in the female: this is one among many reasons why femoral hernia is less frequent in the male. It is necessary to be aware that, in reference to the axis of the body, the plane of the ligament is very nearly horizontal, and, therefore, that it recedes from the surface.

9. *Arrangement of the parts which pass under the arch.*—The crural arch transmits from the abdomen into the thigh (proceeding in order from the outer side)—1, the iliacus and psoas muscles, with the anterior crural nerve between them; 2, the femoral artery and vein.* These muscles and vessels completely fill up all that part of the arch which belongs to them. Still there is, on the inner side of the vein, a comparatively vacant space left for the passage of the absorbents: this is called the femoral aperture or ring. The muscles are separated from the vessels by a very strong vertical fibrous partition passing from the arch to the bone, which is, in point of fact, nothing more than a continuation of the sheath of the psoas. The artery, too, is separated from the vein by another similar, although a much weaker partition, and there is a third close to the inner side of the vein.† These three partitions in the arch may be compared to so many bars, which keep all the parts in their right place, and besides answer the important purpose of confining the arch down to the bone, and preventing its being uplifted by any protrusion between it and the muscles and vessels. This, coupled with the close attachment of the iliac fascia to the crural arch, explains why a femoral hernia cannot take place in any other situation than on the inner side of the femoral vein.‡

* We purposely omit in the text, as unimportant, the cutaneous branches of the lumbar plexus of nerves.

† This description is taken from an horizontal section of the parts.

‡ If the bars, from any cause, yield, or become slack, then a rupture may descend in front of the vessels, or even (though this is extremely rare) on the outer side of the artery.

10. *Femoral aperture.*—We have explained that the hollow under the crural arch is completely occupied, except for a small space on the inner side of the vein. This weak part is called the femoral aperture, and through this a hernia may protrude. Now in order to form a correct idea of the size and other matters concerning this opening, we should remove the peritoneum, and introduce the end of the little finger into it from the abdomen. This can be done without much force. We then find that the finger is girt pretty tightly on all sides: in front, there is the crural arch; behind, there is the bone; on the outer side there is the femoral vein; and on the inner side there is the thin wiry edge of Gimbernat's ligament. Such are the boundaries of the gap which the finger makes. At the same time we are to remember that, in the undisturbed condition of the parts, there is no gap at all; there is only a weak place here, which, when a hernia escapes through it, feels very much like a ring: hence it is commonly described under the name of the femoral ring.*

Let us now push the finger (and this generally requires some force) a little further, say for an inch or so, down the thigh. Where does the finger pass? Into what is called the funnel-shaped sheath of the femoral vessels. This, therefore, we must now endeavour to describe.

11. *Sheath of the femoral vessels.*—The femoral vessels do not descend naked, as it were, beneath the crural arch, but bring down with them from the pelvis a proper investing sheath, just such as other large vessels have. In addition to this, however, in their passage beneath the arch they receive another covering, which, though at first distinct from the proper sheath, is very soon lost upon it. This additional covering appears to be derived immediately from the arch itself, but it is not so: it is, in point of fact, a continuation of the fascia transversalis of the abdomen, and is completed on the inner side by a tough membrane proceeding from Gimbernat's ligament. Upon the whole, we can imagine that this

* The femoral ring is naturally occupied by a little fat and cellular membrane, by absorbent vessels, and often by a small absorbent gland. But we have never met with anything deserving the name of a "diaphragm" or membranous septum, such as is described by Cloquet as the "septum crurale."

covering, by uniting with the pubic portion of the muscular fascia, forms a sort of funnel, with the wide part uppermost, into which the femoral vessels enter. This is what is meant by the funnel-shaped sheath of the femoral vessels.

To examine this sheath satisfactorily, it would be necessary to remove the crural arch and part of the muscular fascia of the thigh. By so doing we should obtain a view of the sheath, and of the manner in which it is formed, abstracted from the surrounding structures. In a practical point of view, the sheath is interesting, for two reasons: 1, because it often constitutes one of the coverings of a femoral hernia; and 2, because in many cases it contains in its substance a pretty strong band of fibres, which crosses over the femoral vessels and the femoral ring just beneath, but quite independent of, the crural arch; so that it forms a kind of second arch, deeper seated than the first. From the situation and direction of this band, it is clear that it would lie immediately over the neck of the sac in a femoral hernia; and it may be of itself sufficiently strong to cause the stricture. Indeed, in the operation for femoral hernia, with or without opening the sac, it is generally requisite to divide this band before the intestine can be returned.

Through the inner side of the sheath the absorbent vessels of the thigh make their way into the abdomen. In some instances they all pass together through a single hole in it of considerable size; in others, there are several small openings for them. It is important to remember this, for a reason which will appear directly. When the finger is introduced from the abdomen into the sheath, we cannot make our way far down, because the sheath soon becomes closely connected with the proper investment of the femoral vessels. What, then, happens if the finger be pushed against the sheath with violence? Either the sheath yields like an elastic membrane, or the point of the finger may protrude through an aperture in it, such as we have just now described as transmitting the femoral absorbents. Now, one or other of these results is precisely what takes place before a femoral hernia.

Surgical writers speak of a *femoral canal.* By this is meant, simply, the passage which a hernia makes for itself as it escapes from the abdomen. There can be no objection to the term, pro-

vided it be understood that the canal has no existence prior to the occurrence of the hernia.

12. *Practical application of the subject.*—From what has been said, we can have no difficulty in understanding—1, at what point a femoral hernia escapes from the abdomen; 2, the course which it takes, and its relations to the surrounding parts; 3, the proper mode of attempting the reduction; 4, the structure and arrangement of its coverings; and lastly, where the stricture will probably be situated.

The hernia escapes from the abdomen through the femoral ring,—that is, under the weak part of the crural arch, between the femoral vein and Gimbernat's ligament. This forms the mouth of the hernial sac, or that part of it which communicates with the abdomen. It descends for a short distance nearly perpendicularly, and projects as a small tumor in front of the pectineus muscle. Here, however, its further progress downwards is arrested by the very close adhesion of the subcutaneous structures to the lower margin of the saphenous opening. Consequently, if the hernia increase in size, it is obliged to rise over the crural arch, where the subcutaneous tissue offers less resistance; and the bulk of the hernia extends outwards towards the ilium, assuming more or less of an oblong form, with the long axis parallel to the crural arch. Since, then, the body of the hernia forms a very acute angle with the neck, the right mode of attempting its reduction is, to make the hernia retrace its steps,—that is, to draw it first down from the groin, and then to make pressure on it backwards in the direction of the femoral canal.

With regard to its *coverings*, the hernia of course protrudes before it the peritoneum, technically called the hernial sac. It next pushes before it the sheath of the femoral vessels, which forms an investment called the *fascia propria*. But, if it make way through an opening on the inner side of the sheath, then there will be no fascia propria over it. Lastly, there is the subcutaneous fat and cellular tissue.*

* Some authors (after Cloquet) speak of a covering derived from what they call the "septum crurale." But we have not met with this in our dissections.

Since the fascia propria is in some instances absent, and in others exceedingly thin, we ought, in operating, to be careful not to make the first incision too deep; for there may be nothing more between the skin and the sac but the subcutaneous tissue.*

The *seat of stricture* is at the femoral ring, and the position of the neighbouring blood-vessels indicates that the proper direction in which to divide the stricture is, either directly inwards, through Gimbernat's ligament, as recommended by Mr. Lawrence, or upwards through Hey's ligament, as recommended by Sir A. Cooper. There is no risk of wounding an artery, supposing the vessels to take their ordinary course. But it occasionally happens (see Dissection of the Abdomen, § 70 *d*) that the obturator artery runs round the inner side of the femoral ring, so that in such a case the neck of the sac would be encircled by a large blood-vessel.† From the examination of two hundred bodies, we conclude that the chances are about seventy to one against this unfavourable distribution. But the possibility of it has given rise to this rule in practice,—not to cut deeply in any one place through the stricture, but rather to notch it in several. By this proceeding we are much less likely to wound the aberrant artery, because it does not run at the base of Gimbernat's ligament, but about a line and a half from the margin of it.

Such is a brief outline of the anatomy of the parts concerned in a femoral hernia. The normal anatomy in each case being nearly the same, one might suppose that all operations for the relief of this kind of hernia would be straightforward and pretty much alike; but this is very far from being the case; indeed, most experienced surgeons will agree that they never take the knife in hand without the expectation of meeting some peculiarity.

* In some cases of femoral hernia the fascia propria so much resembles the hernial sac, that it is not easy to distinguish between them. Generally speaking they are separated by a small quantity of fat.

† The museum of St. Bartholomew's Hospital contains two examples of double femoral hernia in the male, with the obturator arising on each side from the epigastric. In three out of the four herniæ the obturator runs on the inner side of the mouth of the sac. See Prep. 55, 69, Series 17.

13. Proceeding now with the general dissection, the incision should be prolonged down the thigh, over the knee, to the tubercle of the tibia. The skin should be reflected, so that the subcutaneous tissue over the whole front of the thigh be fairly exposed; our present object being to examine the cutaneous veins and nerves.

14. *Cutaneous veins and nerves.*—The course of the saphena vein, its tributary branches, and the confluence of veins observed at the saphenous opening, have been sufficiently described at § 5. We would merely observe here, that all the larger cutaneous veins of the thigh, and the same obtains of the leg generally, are so situated as to be out of the way of harm. Respecting the cutaneous nerves a very general account is sufficient, since they are not exactly alike in any two subjects. They are usually divided, according to their situation, into *external, middle,* and *internal.* All, directly or indirectly, proceed from the lumbar plexus, and may be seen coming through the muscular fascia.

a. The *external cutaneous* nerve is a distinct branch of the lumbar plexus (see Dissection of the Abdomen, § 39, *b*). It enters the thigh beneath the crural arch, near the anterior spine of the ilium, and can be traced down the outer side of the thigh to the knee, giving off numerous branches, which again divide and subdivide to supply the skin.

b. The *middle cutaneous* nerves, two or more in number, are derived from the anterior crural (which itself is a large branch of the lumbar plexus.) They come through the fascia about four or five inches below the crural arch, not all, however, at the same spot, and then descend along the front of the thigh to the knee, distributing branches on either side.

c. The *internal cutaneous* nerves, two or more, also branches of the anterior crural, perforate the fascia, one about the middle, another about the lower third of the thigh, and supply the skin on the inner side.*

By careful dissection we find that these several nerves communi-

* Besides these, there is the small crural branch of the genito-crural nerve (see Dissection of Abdomen, § 39, *c*), which perforates the fascia about two inches below the crural arch. This is seldom found except by an experienced dissector.

cate here and there with each other, and this more especially over the patella.*

15. *Muscular fascia.*—Let us now remove the subcutaneous structure, in order to examine the muscular fascia, or what is commonly called the "fascia lata" of the thigh. The general purpose of this fascia is to clothe the muscles of the thigh collectively, and to form separate sheaths for each; so that it not only packs them up together, but maintains each in its proper position. We shall see the partitions when we come to separate the muscles: it is sufficient to mention at present that a knowledge of them is practically important, because they interfere with the progress of deep-seated matter towards the surface, and cause it to burrow in this or that direction according to the part in which it forms.

The fascia is by no means of equal strength all round the thigh. As one might expect, it is strongest in the most exposed parts; *e. g.* it is comparatively thin and transparent on the inner side, but exceedingly thick and strong all down the outer side: here, indeed, it has the appearance of a dense expanded tendon, strapping down the vastus internus muscle; and it certainly performs the office of a tendon, for we shall presently see that it gives insertion to two powerful muscles,—namely, the tensor fasciæ femoris, and the glutæus maximus.

But what are its attachments? In a general way, it may be said that it is attached to the margin of the bones which constitute the framework of the lower extremity. For instance, beginning from above, we could, if the parts were exposed, trace its attachment along the crest of the ilium, thence along the crural arch to the body of the pubes, and so on down the border of the pubic arch. Proceeding down the thigh, we should find that it penetrates, on either side of the limb, to the linea aspera, forming what are called the "intermuscular septa," which separate the extensor from the flexor muscles. Below we trace it all round the knee-joint, where it is particularly strong, especially on the outer side, and find that it is attached into the head of the tibia and the fibula. Here let us leave it for the present.

* Some authors even speak of a "patellar plexus" of nerves.

The next stage of the dissection consists in removing the muscular fascia from the front of the thigh, without disturbing the muscles from their relative position. Our chief object should be to learn the origin, insertion, and respective position of the muscles: for, without such previous knowledge, how can we expect to understand the course of the arteries? The mass of muscles on the inner side of the thigh consists of adductors; that in the middle, of extensors, while the long muscle which crosses obliquely over the front is the sartorius. This we will take first, being a sort of land-mark to the rest.

16. *Sartorius.*—This muscle arises from the anterior superior spine of the ilium, and more or less of the ridge below. It passes obliquely, like a strap, over the front of the thigh towards the inner side, and then descends almost perpendicularly on the inner side of the knee, where it terminates in a tendon which widely expands and is inserted into the inner and front part of the tibia just below the tubercle. The tendon appears all the wider on account of its broad connection with the fascia of the leg. A large bursa* is interposed between the tendon and the bone. The chief *action* of the muscle is to fix the pelvis steadily on the thigh. It can also cross one leg over the other, as tailors are in the habit of doing when sitting at work.†

The most important practical point about the muscle is, that it overlaps the femoral artery in the middle of the thigh; and the inner border of the muscle is the guide to the vessel in the situation where it is usually tied for a popliteal aneurism.

17. *Gracilis.*—Passing in the next place to the adductors on the inner side of the thigh, we should examine another long flat muscle, called the gracilis. To dissect it properly, it should be put on the stretch by separating one thigh from the other. It arises by a broad ribbon-like glistening tendon from the pubes

* In persons, females especially, who are in the habit of riding, this bursa sometimes becomes enlarged.

† Hence the name given to it by Spigelius (De corporis hum. fabric.) "Quem ego sartorium musculum vocare soleo, quod sartores eo maximè utuntur, dum crus cruri inter consuendum imponunt."

close to the symphysis, and from the border of the pubic arch nearly as low as the tuber ischii. The muscle descends perpendicularly on the inner side of the thigh, and terminates on a tendon which spreads out and is inserted into the inner side of the tibia below the tubercle; in fact, just like the sartorius, only below it, so that the one overlaps the other. Both tendons play over the internal lateral ligament of the knee-joint, and there is a bursa common to both. This muscle assists in fixing the pelvis, and in adducting the thigh.

18. Adductor muscles.—A strong group of muscles extends, along the inner side of the thigh, from the pelvis to the femur. Their chief action is to co-operate in balancing the pelvis steadily on the thigh,—as, for instance, in standing on one leg; or, if the fixed point be reversed, they can draw the thighs together,—as, for example, in riding. Physiologically, therefore, they might be considered as one, for they are supplied by the same nerve,—namely, the obturator; but anatomically they are divided into three—the adductor longus, brevis, and magnus. Since they lie in strata, we should reflect them from their origin and examine each in succession, taking care not to divide the branches of the obturator nerve which supply them.

19. *Adductor longus.*—This muscle arises by a tendon from the front of the pubes just below its spine, and, gradually becoming broader, is inserted into about the middle third of the linea aspera of the femur. It forms with the sartorius a V-shaped space, in which are contained the several muscles, vessels, and nerves, which descend beneath the crural arch,—namely, (beginning from the iliac side), the iliacus and psoas muscles, with the anterior crural nerve in a groove between them, the femoral artery and vein, and the pectineus muscle.

The psoas and iliacus having been described in the dissection of abdomen, § 32, we have now to describe only the pectineus, which is, in point of fact, an adductor.

20. *Pectineus.*—This muscle lies close to, and on the same plane with, the adductor longus. It arises from the smooth angular surface of the pubes in front of the crest, and is inserted

into the upper half of the ridge leading from the lesser trochanter to the linea aspera.

21. *Adductor brevis.*—This muscle may be exposed by reflecting the adductor longus. It arises from the front surface of the pubes near the symphysis, widens as it descends, and is inserted all down the ridge leading from the lesser trochanter to the linea aspera. By reflecting this muscle from its origin we expose the following:*—

22. *Adductor magnus.*—This muscle arises from the lower two-thirds of the pubic arch and from the tuberosity of the ischium. Its fibres spread out, and are inserted, behind the other adductors, into the whole length of the linea aspera, and also into the ridge leading from it to the inner condyle. It should be observed that all the adductor muscles are inserted into the femur by flat tendons which are more or less connected with each other.

About the junction of the upper two-thirds with the lower third of the thigh, the femoral artery passes through an oval opening in the tendon of the adductor magnus.

23. *Tensor fasciæ femoris.*—This muscle is situated at the upper and outer part of the thigh. It arises from the crest of the ilium, close to the anterior spine, descends with a slight inclination backwards, and is inserted between two layers of the strong aponeurosis which is generally described as part of the fascia lata. Its chief use is to fix the pelvis steadily on the thigh, and also to rotate the thigh inwards: in this last respect it co-operates with the anterior fibres of the glutæus medius, with which it is almost inseparably connected. Any one may convince himself of this by placing the hand on the hip and rotating the thigh inwards. There are no other muscles to do it, and both are supplied by the same nerve,—namely the superior glutæal.

a. In order to form an adequate idea of the strength, extent, and connections of the aponeurosis on the outer side of the thigh,

* Beneath the adductor brevis, and just above the upper border of the adductor magnus, is seen the obturator externus. But we think it better to reserve the description of this muscle till the dissection of the other external rotators of the thigh.

we ought to separate it from the vastus externus muscle upon which it lies. There is no difficulty in doing so, for it is united to the muscle by an abundance of loose cellular tissue.* With a little perseverance we can trace the aponeurosis to the linea aspera and the head of the fibula, and we see how completely it protects the outer side of the knee-joint.

24. Extensor muscles.—The powerful muscles situated between the tensor fasciæ on the outer, and the sartorius on the inner side, are extensors of the leg, and all are supplied by branches of the anterior crural nerve. One of them—namely, the rectus—arises from the pelvis; the other—namely, the triceps—arises from the shaft of the thigh bone by three portions, called respectively the cruræus, the vastus externus, and internus.

25. *Rectus.* This muscle arises from the pelvis by two strong tendons, which soon unite, one from the inferior spine of the ilium, the other from the rough surface of the ilium, just above the acetabulum. To see them, we should dissect between the sartorius and the tensor fasciæ, and in doing so we should be careful not to injure the branches of the external circumflex artery. The muscle descends perpendicularly down the front of the thigh, and is inserted into the common tendon of the extensors. Its structure is worth noticing. A tendon runs down the centre, and the muscular fibres are implanted on either side of it, like the vane on the shaft of a feather.

26. *Triceps extensor.* This mass of muscle immediately surrounds and takes origin from the greater part of the shaft of the femur; therefore the whole extent of it cannot be seen without completely dissecting the thigh. It consists of an outer, middle, and inner portion, called respectively the vastus externus, the cruræus, and the vastus internus. The *vastus externus* arises from the upper three-fourths of the outer side of the shaft of the femur, commencing below the great trochanter; also from the linea aspera and the upper part of the ridge leading to the outer condyle. The

* When this tissue becomes the seat of suppuration, the matter is apt to extend all down the outside of the thigh, not being able to make its way to the surface by reason of the dense fascia.

cruræus arises from the upper three-fourths of the front surface of the shaft. The *vastus internus* arises from the upper two-thirds of the inner surface of the shaft, and also from the linea aspera.

a. Common extensor tendon. The tendon of the rectus, gradually expanding, receives on its under surface the insertion of the cruræus,* and on either side that of the vasti, and is firmly fixed into the upper part and sides of the patella. From this bone the strong ligamentum patellæ descends over the front of the knee joint, and is implanted into the tubercle of the tibia. But besides this, the lower fibres of the vasti terminate on a sheet-like tendon, which runs wide of the patella on either side, and is directly inserted into the sides of the head of the tibia, so that the knee is completely protected all round. The patella is a great sesamoid bone, interposed like a pulley to facilitate the play of the tendon over the condyles of the femur; it not only materially protects the joint, but adds to the power of the extensor muscles, by increasing the angle at which the tendon is inserted into the tibia.

The *action* of the extensor muscles is too obvious to require explanation. Their all importance is manifested by what happens in cases of fracture of the patella. We will merely observe that the rectus, by arising from the pelvis, gains a double advantage. 1. It contributes to balance the pelvis on the thigh. 2. It can act upon two joints simultaneously, bending the one while it extends the other; as *e. g.* when the leg is advanced in walking. To facilitate the play of the extensor tendon there are two bursæ, which we must not omit to examine at a future stage of the dissection. One is placed between the ligamentum patellæ and the tubercle of the tibia, the other between the cruræus and the lower part of the femur. This last is of very considerable size. In early life it is,

* A few of the deeper fibres of the cruræus are inserted into the fold of the synovial membrane of the knee-joint which rises above the patella. These are described as a distinct muscle, under the name of the *sub-cruræus*. Their use is to raise the synovial membrane, so that it may not be injured by the play of the patella. Since the triceps is connected to the lower part of the shaft of the femur only by loose cellular tissue, there is nothing to prevent the distension of the synovial membrane, in cases of inflammation, to the extent of several inches above the patella.

as a rule, distinct from the synovial membrane of the knee-joint; but after a few years of friction we generally find a wide communication between them.

We must here say a few words respecting the structures which cover the patella. The skin over it is exceedingly loose, and in the subcutaneous tissue there is a bursa of considerable size. Since this bursa is apt to enlarge and inflame in females who are in the habit of kneeling, it generally goes by the name of "the housemaid's bursa." It is worth observing that the bursa is not seated exactly on the top of the patella, but that it extends some way down the ligamentum patellæ; indeed, in some cases it is entirely confined to this ligament. This quite corresponds with the position of the tumor which the bursa occasions when enlarged. Generally speaking, in subjects brought for dissection, the wall of the bursa is more or less thickened, and its interior intersected by numerous fibrous cords, which are remnants of the original cellular structure altered by long-continued friction. Again, the wall of the bursa does not always form a complete sac; sometimes there is a wide opening in it; this explains the rapidity with which inflammation, in some cases, extends from the bursa into the surrounding cellular tissue.

Below the bursa over the patella there is a layer of fascia lata, and under this there is a beautiful network of arteries. The immediate covering of the bone, or what may be called its periosteum, is a strong expansion derived from the extensor tendon. This is practically interesting for the following reason: in ordinary fractures of the patella from muscular action the tendinous expansion over it is torn also; the ends of the bone gape widely, and never unite except by ligament. But in fractures from direct mechanical violence, the expansion being, generally speaking, entire, maintains the fragments in apposition, so that there is commonly a bony union.

Having studied so far the anatomy of the muscles, we should replace them as much as possible in their natural position, in order to examine the course and relations of the femoral artery.

27. Course and relations of the femoral artery.— The femoral artery is a continuation of the external iliac. Passing

beneath the crural arch at a point about midway between the spine of the ilium and the symphysis pubis, it descends nearly perpendicularly along the front and inner side of the thigh. At the junction of the upper two-thirds with the lower third of the thigh, it goes through an opening in the tendon of the adductor magnus, and, entering the ham, takes the name of popliteal. Thus a line drawn from the point specified of the crural arch, to the inner border of the patella, would pretty nearly indicate the course of the artery, although its distance from the surface increases as it descends. Next, as to the muscles over which it lies. Immediately under, and for a short distance below the crural arch, it is supported by the inner border of the psoas; lower down it runs in front of the pectineus, and, still lower, upon the adductor longus.

In about the upper third of the thigh the artery is comparatively superficial, being covered only by the muscular fascia. About the middle third it is more deeply seated, and is covered by the sartorius: here, being situated among powerful muscles, it is protected from pressure by a sort of tendinous canal, which we shall presently describe.

At the crural arch the femoral vein is on the inner side of the artery, but as the vein descends it gradually passes behind the artery. Both lie close together, and are enclosed in a common sheath.

a. The anterior crural nerve passes beneath the crural arch about half an inch on the outer side of the artery, and soon divides into a lash of branches, some of which are cutaneous, but the greater number supply the extensor muscles. Those branches which more directly concern the artery, and are liable to be injured in the operation of tying it, are as follows:—1. The *long saphenous.* This descends close to the outer side of the artery, and enters the tendinous sheath with it, in the middle third of the thigh. Here the nerve crosses over to the inner side of the artery, and leaves it just before it becomes popliteal. The nerve then runs in company with the anastomotica magna artery to the inner side of the knee, where we find it nearly superficial between the gracilis and the sartorius. Finally, joining the saphena vein, it descends with it to the inner side of the foot. 2. Besides the long saphenous,

there are two cutaneous branches, which cross over the sheath of the artery just where the sartorius begins to overlap it, and therefore in the situation where it is usually tied. They lie so close to the sheath that they would run great risk of being injured unless specially looked after. Both* eventually supply the skin on the inner side of the thigh.

We have already mentioned that in the middle third of the thigh the femoral artery is contained in a tendinous canal† under the sartorius. This canal is at its upper part rather indistinct; but it gradually becomes stronger towards the opening in the tendon of the triceps. Its boundaries are formed chiefly by the tendons of the muscles between which the artery runs. On the inner side there are the tendons of the adductor longus and magnus; on the outer side there is the tendon of the vastus internus, while in front the canal is completed by an aponeurotic expansion thrown across from one side to the other. In a horizontal section the canal would appear triangular. The adaptation of this shape to the exigencies of the case is manifest when we reflect that the muscles keep the sides of the triangle always tight, and thereby prevent any compression on the vessels.

After an examination of the course and relations of the femoral artery, it naturally suggests itself that a ligature can be placed around it, in the upper third of the thigh, with comparative facility, but not so easily in the middle third. The usual situation in which the artery is tied for an aneurism of the popliteal, is where the sartorius begins to overlap it. An incision, beginning about three inches below the crural arch, should be made about three inches over the line of the artery. The muscular fascia should next be divided over a director to the same extent. Then, by gently drawing aside the inner border of the sartorius, we discover the

* It is one of these nerves which generally joins a branch of the obturator, near the lower border of the tendon of the adductor magnus.

† Sometimes called "Hunter's canal," because it was in this part of its course that John Hunter first tied the femoral artery for aneurism of the popliteal, in St. George's Hospital, A. D. 1785. The particulars of this interesting case are published in the Trans. for the Improvement of Med. and Chir. Knowledge.

artery enclosed in its sheath with the vein. An opening should be made into the sheath just sufficient to admit the passage of the aneurismal needle, and this should be turned round the artery, from within outwards. The nerves to be avoided are—the long saphenous, which runs along the outer side of the artery, and the two other cutaneous nerves which cross obliquely over it.*

Having already examined, at the outset of the dissection, the cutaneous branches of the femoral artery met with in the groin, we pass at once to the description of the profunda.

28. *Profunda artery.*—This is the chief branch of the femoral artery, and is, in fact, the proper nutritious artery of the thigh. It arises from the outer and back part of the femoral, about one and a half or two inches below the crural arch, and runs down behind the femoral till it reaches the tendon of the adductor longus; here the profunda passes behind the adductor, and is finally lost in the hamstring muscles. We observe, in most subjects, that for a short distance after its origin it lies rather on the outer side of the femoral, over the psoas muscle, so that in this situation it might be mistaken for the femoral itself,—indeed, such an error has actually occurred in practice. It soon, however, gets quite behind the femoral, but is never in actual contact with it, for the two arteries are separated by their corresponding veins.

The profunda gives off its branches generally in the following order:—1, the internal circumflex; 2, the external circumflex; 3, the perforating.

a. The *internal circumflex* sinks deep into the thigh between the psoas and pectineus muscles. Here for the present we lose it; but we shall find it again in the dissection of the back of the thigh, between the adductor magnus and the quadratus femoris. It supplies numerous branches to the muscles in its neighbourhood,—namely, to the pectineus, psoas, the adductors, and the quadratus femoris. It also sends branches to the hip-joint, and one especially which runs through the notch in the acetabulum to the ligamentum teres.

* The nerve (sometimes called the short saphenous) which supplies the vastus internus is so far out of the way, that it could not be included in the ligature, except by a very careless operator.

b. The ~~*in*~~ex*ternal circumflex* runs transversely outwards beneath the sartorius and the rectus, through the divisions of the anterior crural nerve, and then subdivides into three sets of branches,—the ascending, transverse, and descending. The ascending proceed to the outer side of the ilium, beneath the tensor fasciæ and the glutæus medius, supply these muscles, and inosculate with the terminal branches of the glutæal artery. The transverse are chiefly lost in the vastus externus. The descending, two or more in number, and of considerable size, run down between the rectus and cruræus, supplying both these muscles, and may be traced as low as the knee, where they inosculate with the articular arteries.

The inosculations between the branches of the circumflex arteries on the one hand, and the gluteal and ischiatic on the other, are the main channels through which a collateral circulation is established, when the femoral is tied above the origin of the profunda.

c. The *perforating* branches are so named because they pass through the adductors to supply the hamstring muscles. There are generally three, but they are apt to vary both in number and size. The first passes between the pectineus and adductor brevis, and then through the tendon of the adductor magnus. The second* passes through the tendons of the adductor brevis and magnus. The third through the tendons of the adductor longus and magnus. All are eventually lost in the flexors of the leg,—namely, the biceps, semi-tendinosus, and semi-membranosus.

After giving off the preceding branches, the continuation of the profunda, much reduced in size, passes through the tendon of the adductor magnus, and is distributed to the short head of the biceps.

29. The *anastomotica magna* arises from the femoral artery just before it leaves its tendinous canal. It runs in front of the tendon of the adductor magnus, in company with the long saphenous nerve to the inner side of the knee. Here it ramifies exten-

* This perforating branch usually furnishes the nutritious artery of the femur.

sively over the capsule, and communicates with the other articular arteries.*

30. *Anterior crural and obturator nerves.*—The anterior crural nerve is the largest branch of the lumbar plexus. (See Diss. of Abdomen, § 39 *d*). We have aleady said that it passes under the crural arch, in a groove between the iliacus and the psoas muscles, and generally about half an inch from the outer side of the femoral artery. It soon divides into a number of branches, some of which supply the skin,—others, the extensor muscles of the thigh. The cutaneous branches,—namely, the long saphenous, the middle and internal cutaneous, have been already described at § 14, 27 *a*. Of its muscular branches we trace one to each of the several muscles which extend the leg. These need not be specified. But it cannot be said that it supplies them only, for it sends a small branch, beneath the femoral vessels, to the pectineus, and one also to the sartorius.

a. The *obturator* nerve, also a branch of the lumbar plexus (see Diss. of Abdomen, § 39 *c*,) is intended for the supply of the adductor muscles. It enters the thigh through the upper part of the obturator foramen with the corresponding artery, and soon divides into two branches, of which one passes in front of, the other behind the adductor brevis. The front branch† subdivides for the supply of the gracilis, the adductor longus and brevis; the hind one, by far the larger, supplies the obturator externus and the adductor magnus. We may, in some bodies, succeed in tracing a filament of the obturator nerve through the notch of the acetabulum into the hip-joint, and another, which runs near the popliteal artery, into the back part of the knee-joint.

There is but little to be said respecting the obturator artery so

* While in its tendinous canal the femoral artery often gives off unnamed muscular branches of considerable size, and more especially one for the supply of the vastus internus. We may trace this branch thiough the substance of the vastus down to the patella, where it joins the beautiful network of vessels on the surface of that bone.

† Near the lower border of the adductor longus: a filament from this branch gene-rally communicates with one of the internal cutaneous branches of the anterior crural nerve.

far as the thigh is concerned. After passing through the foramen it generally divides into two branches, which form a circle round the obturator membrane. These supply the external obturator muscle, but rarely any other muscle of the thigh. Sometimes it gives off the little artery to the ligamentum teres of the hip-joint.

DISSECTION OF THE FRONT OF THE LEG.

31. Let the incision be continued from the knee down the front of the leg, over the ankle, and along the top of the foot to the great toe. Another incision must then be made at right angles to the first, on either side of the ankle, so that the skin may be fairly reflected from the front and sides of the leg and foot.

32. *Cutaneous veins and nerves.*—Having already traced the internal saphena vein (§ 5) to the inner side of the knee, we have now to follow it down the inner side of the leg, and over the inner ankle* to the top of the foot. On the top of the foot we notice that the principal veins form a kind of arch, with the convexity forwards, just as on the back of the hand. This arch receives the veins from the toes. From the inner side of the arch the internal saphena originates; and from the outer side the external saphena. The latter vein runs behind the external ankle, and then up the calf of the leg to join the popliteal vein; so that we cannot follow it for the present.

With regard to the cutaneous nerves, we have to observe that the skin on the inner side of the leg is supplied by the long saphenous nerve. In the dissection of the thigh, we found that this nerve became subcutaneous on the inner side of the knee, between the gracilis and sartorius. Here it meets the saphena vein, and subsequently accompanies it down the leg, distributing its branches on either side, till it is finally lost on the inner side of the foot. But the largest branch curves round the inner side of the knee, just below the patella, to supply the skin in this situation.

* The French commonly bleed from the internal saphena as it runs over the inner ankle, this being a convenient and safe place for venesection.

a. External cutaneous nerve.—About the lower third of the outer side of the leg we find that a nerve of considerable size comes through the muscular fascia, and then descending over the front of the ankle, divides and subdivides over the top of the foot. This, it will subsequently appear, is a branch of the peroneal nerve. By tracing its subdivisions we observe that one runs along the inner side of the foot to the inner side of the great toe; the others supply the outside of the second toe, both sides of the third and fourth, and inside of the little toe.

b. The outside of the foot and little toe is supplied by the external saphenous nerve, which runs behind the outer ankle with the corresponding vein.

c. The contiguous sides of the great toe, and the toe next to it, are supplied by the termination of the anterior tibial nerve, which is seen in the first interosseous space.*

33. *Muscular fascia.*—This is remarkably thick and strong. Over and above its general purpose of forming sheaths for the muscles, and straps for the tendons, it gives origin, just as in the forearm, to some of the subjacent muscular fibres; so that it cannot be removed from the surface of the muscles, near the knee, without leaving them ragged. We observe that the fascia is attached to the head of the tibia and the fibula, and that it is identified on the inner side with the expanded tendons of the sartorius, gracilis, and semi-tendinosus; and on the outer side with that of the biceps; consequently, when these muscles respectively act, the fascia is rendered tense. Following it down the leg, we find that it is attached to the edge of the tibia, and that it gradually becomes stronger as it approaches the ankle, because it has to form ligaments for the purpose of confining the tendons in this situation. Of these ligaments, which are called *annular*, there are three, as follows:—

a. The *anterior* extends obliquely across the front of the joint between the malleoli, and confines the extensor tendons of the ankle and toes.

* Such is the most common distribution of the several nerves to the upper surface of the toes. But it should be understood that deviations from this arrangement are frequent.

b. The *external* extends between the outer malleolus and the os calcis, and confines the tendons of the peronei muscles, which draw the foot outwards.

c. The *internal* extends between the inner malleolus and the os calcis, and binds down the flexor tendons of the foot and toes.

Further, it is to be observed that the tendon or tendons, as the case may be, proceeding from any given muscle, is contained in a sheath or pulley of its own, separate from the rest, and that this sheath is lined by a synovial membrane, which is reflected over the tendon, so that it plays without friction.

On the top of the foot the fascia is attached to the margin of the bones on either side, and the direction of its fibres just below the ankle is such that they cross like the letter X.

We must next remove the fascia, leaving enough of the annular ligaments to retain the tendons in their proper place.

Muscles on the front of the leg.—We have to examine—1, the tibialis anticus; 2, the extensor longus digitorum and peroneus tertius; 3, the extensor proprius pollicis.

34. The *tibialis anticus* arises from the upper two-thirds of the outer side of the tibia, from the interosseous membrane, and from the fascia which covers it. About the lower third of the leg the fibres terminate on a strong flat tendon, which descends rather obliquely over the front of the ankle to the inner side of the foot: here it becomes a little broader, and is inserted into the internal cuneiform bone and the adjoining end of the metatarsal bone of the great toe. The synovial membrane, which lines the sheath of the tendon beneath the annular ligament, generally accompanies it to within an inch of its insertion; consequently it is necessarily opened when the tendon is divided for club-foot. The action of this muscle is to draw the foot inwards.* This movement, among many others, assists us in balancing the body,—as, *e. g.*, in standing upon one leg.

35. The *extensor longus digitorum* lies along the fibular side of

* It is generally necessary to divide this tendon in distortion of the foot inwards, called "talipes varus."

the preceding. It arises from the outside of the head of the tibia, from the upper two-thirds of the front surface of the fibula, from the interosseous membrane and the fascia. Its fibres terminate in a penniform manner upon a long tendon which descends over the ankle and then divides into four. These diverge from each other, and are inserted into the toes in the following manner :—On the first phalanx, each tendon (except that of the little toe) is joined on its outer side by the corresponding tendon of the extensor brevis. The united tendons then expand, and are inserted just as on the fingers; that is, the middle part is inserted into the base of the second phalanx, while the sides run on to the base of the third.

Immediately below the ankle the fascia forms a beautiful pulley through which the tendon of this muscle plays. It may be compared to a sling, of which the two ends are attached to the upper part of the os calcis, while the loop serves to confine the tendon. The play of the tendon is facilitated by a synovial membrane, which is prolonged for a short distance along each of its four divisions.

Besides its ordinary action, this muscle can also extend the ankle-joint.

a. The *peroneus tertius* appears like a portion of the preceding. Its fibres arise from the inner and front surface of the lower part of the shaft of the fibula, and terminate on their tendon like barbs on a quill. The tendon passes through the same pulley with the long extensor of the toes, and, expanding considerably, is inserted into the tarsal end of the metatarsal bone of the little toe. Its action is to extend the foot and turn it slightly outwards.

36. *Extensor proprius pollicis.*—This muscle lies partly concealed between the tibialis anticus and the extensor longus digitorum. It arises from rather more than the middle third of the inner side of the fibula, and from the interosseous membrane. The fibres terminate in a penniform manner on the tendon, which we trace over the front of the ankle, and along the top of the foot, to the great toe, where it is inserted into the base of the last phalanx. It has a special pulley beneath the angular ligament, lined by a

synovial membrane, which accompanies it as far as the metatarsal bone of the great toe.

37. *Extensor brevis digitorum.*—This muscle is situated on the top of the foot, beneath the long extensor tendons of the toes. It arises from the front part of the os calcis, and from the ligaments uniting this bone to the astragalus. The fibres run rather obliquely over the foot, and terminate on four tendons, which join the fibular side of the long extensor tendons of the four inner toes.

We should now examine the course, relations, and branches of the anterior tibial artery. Since it lies deep between the muscles, it is necessary to separate them from each other; and this is easily done by proceeding from the ankle towards the knee. It is also advisable to dissect the tibialis anticus out of the bed in which it lies.

38. Course and relations of the anterior tibial artery.—The anterior tibial artery is one of the two branches into which the popliteal divides at the lower border of the popliteus muscle. It comes forwards immediately below the head of the fibula, and descends with a slight inclination inwards along the interosseous membrane. It then runs beneath the annular ligament over the front of the ankle, and along the top of the foot to the interval between the first and second metatarsal bones, where it sinks into the sole and joins the deep plantar arch. Thus, a line drawn from the junction of the heads of the tibia and fibula to the interval between the first and second metatarsal bones would nearly coincide with its course. In the upper third of the leg it lies deep between the tibialis anticus, and the extensor longus digitorum; in the lower two-thirds, between the tibialis anticus and the extensor proprius pollicis. But in front of the ankle the artery is crossed by the extensor proprius pollicis, so that on the top of the foot it runs along the outer side of this tendon. Again, just before it sinks into the sole, it is crossed by the short extensor tendon of the great toe.

The artery is closely accompanied by a nerve (a branch of the peroneal), which runs for some distance on its fibular side, and, after crossing it once, is generally found on its fibular side, on the

top of the foot. It is also accompanied by two veins, one on either side, which communicate at intervals by cross branches.

The best guide to the artery in the upper part of its course is the inner edge of the fibula; on the top of the foot, the long extensor tendon of the great toe.

39. The *branches of the anterior tibial* are as follows:—

a. The *recurrent* branch ascends close by the outer side of the head of the tibia to the knee-joint, where it inosculates with the other articular arteries.

b. Irregular *muscular* branches.

c. The *malleolar* branches, external and internal, ramify over the ankle, supplying the joint; the articular ends of the bones, and the sheaths of the tendons around them.

d. The *tarsal* branch arises near the navicular bone, passes beneath the extensor brevis digitorum to the outside of the foot, supplies the bones and joints of the tarsus, and inosculates with the arteries in the sole.

e. The *metatarsal* branch generally runs towards the outside of the foot, near the bases of the metatarsal bones, and gives off the three outer interosseous arteries. These pass forwards over the corresponding interosseous muscles, supply them, and then subdivide so as to supply the opposite sides of the upper surface of the toes. They usually communicate by what are called perforating branches with the plantar arteries.

f. The *dorsalis hallucis* is, strictly speaking, the artery of the first interosseous space. It comes from the anterior tibial just before this sinks into the sole, and runs forwards to supply the opposite sides of the two first toes.

40. *Peronei muscles.*—These muscles are situated on the outer side of the fibula, and are named respectively the peroneus longus and brevis.

a. The *peroneus longus* arises from the outer surface of the fibula along its upper half. The fibres terminate in a penniform manner upon a tendon, which runs through a groove behind the outer ankle, then along the outer side of the os calcis, and lastly, through a groove on the under surface of the os cuboides into the

sole. We shall presently find that it crosses the sole obliquely, and is inserted into the tarsal end of the metatarsal bone of the great toe. In its course through these several bony grooves the tendon is confined by a fibrous sheath, lined by a synovial membrane.

b. Peroneus brevis.—This muscle lies beneath the preceding. It arises from the lower half of the outer surface of the shaft of the fibula. It terminates on a tendon which runs behind the outer ankle, through the same sheath with the peroneus longus, and then proceeds along the outside of the foot, and is inserted into the tarsal end of the metatarsal bone of the little toe.

The *action* of the peronei is to raise the outer side of the foot.* This movement regulates the bearing of the foot in progression, so as to throw the principal part of the weight on the ball of the great toe. Its action is particularly well exemplified in skating. Again, supposing the fixed point to be at the foot, they tend to prevent the body from falling on the opposite side, as *e.g.*, when we balance ourselves on one leg.

Our next object should be to trace the nerves which supply the muscles we have been examining.

41. *Peroneal nerve.*—Near the inner side of the tendon of the biceps flexor of the leg there is a large nerve called the peroneal, a branch of the great ischiatic. By carefully reflecting just the upper part of the peroneus longus, we find this nerve coming forwards close to the fibula, immediately below its head. Here the nerve divides into several branches, with most of which we are already familiar. To enumerate them collectively, there is, 1. a small articular branch, which accompanies the recurrent artery to the knee-joint. 2. The anterior tibial, which accompanies the corresponding artery. 3. The external cutaneous, which comes through the fascia between the peroneus longus and the extensor longus digitorum. With a little dissection we shall find that these nerves supply all the muscles of this part of the leg, namely, the extensors of the foot and the toes and the peronei.

* In distortion of the foot outwards, called "talipes valgus," it is generally necessary to divide the tendons of the peronei.

DISSECTION OF THE GLUTÆAL REGION.

42. The incision through the skin should commence at the coccyx, and be continued in a semicircular manner along the crest of the ilium. Another incision should be made from the coccyx, downwards and outwards for about six inches below the great trochanter. In reflecting the skin, we notice the elastic cushion which the subcutaneous tissue forms over the tuberosity of the ischium, and it occasionally happens that we find a large bursa between the cushion and the bone.

Unless the learner desire to trace the cutaneous nerves, which, by the way, is no easy task, he should at once lay bare the great glutæal muscle, beginning at its front border, and dissecting in the course of its fibres.

43. The *cutaneous nerves* are derived from several sources. Some descend over the crest of the ilium, near the origin of the erector spinæ; these are the posterior divisions of the first and second lumbar nerves, the latter being by far the larger. About the middle of the crest we find the lateral branch of the twelfth dorsal nerve, and often a smaller one from the first lumbar. Other cutaneous nerves come up from below: these are branches of the lesser ischiatic, and proceed from beneath the lower border of the glutæus muscle. Lastly, the skin of the sacrum and coccyx is supplied by the posterior branches of the sacral nerves.

44. Glutæal muscles.—These are three powerful muscles on the buttock, placed one above the other, and named, according to their relative size, the glutæus maximus, medius, and minimus. The first is entirely subcutaneous, so is, likewise, a portion of the second; but we observe that the latter is covered by a very strong layer of fascia, while the former is not.

45. *Glutæus maximus.*—This great muscle is remarkably thick and coarse in its texture, so that it is perhaps the most difficult in the body to dissect neatly. It arises from the rough surface of bone just below the posterior fifth of the crest of the ilium, from the lower part of the sacrum, from the coccyx, and lastly, from the great sacro-ischiatic ligament. The fibres descend obliquely for-

wards, and are inserted thus:—the anterior two-thirds terminate on a strong broad tendon which plays over the great trochanter, and forms part of the aponeurosis on the outside of the thigh; the remaining third is directly inserted into the femur, along the ridge leading from the linea aspera to the great trochanter.

This muscle is one of those mainly concerned in raising the body from the sitting to the erect position, and in maintaining it erect.

The glutæus maximus should be reflected from its origin, and the best way to do so is to begin at the front border, which overlaps the glutæus medius. But this dissection is difficult, and he who undertakes it for the first time is almost sure to damage the subjacent parts. The numerous nutrient vessels which enter its under surface must necessarily be divided. Supposing the object accomplished, what have we exposed beneath? The muscle covering the ilium is the glutæus medius. At the posterior border of this we find the several objects which come out of the pelvis through the great ischiatic notch—namely, the pyriformis muscle, above which is the trunk of the glutæal artery with the glutæal nerve, and below which are the greater and lesser ischiatic nerves, the ischiatic artery and the pudic artery and nerve. Coming through the lesser ischiatic notch, we see the tendon of the obturator internus, and tacked on to it are the little gemelli muscles, the one above, the other below it. Extending from the tuber ischii to the great trochanter is the quadratus femoris. Lastly, where the tendon of the glutæus maximus plays over the trochanter major, there is a large bursa, simple or multilocular. We have seen it in some subjects sufficiently capacious to hold half a pint of fluid. All these objects must now be severally examined.

46. *Glutæus medius.*—This muscle arises from the surface of the ilium, between the crest and the upper curved line, and also from the strong fascia which covers it towards the front. The fibres converge to a tendon which is inserted into the upper and outer surface of the great trochanter, and there is generally a bursa between it and the bone; but some of the anterior fibres—those, namely, in immediate connection with the tensor fasciæ,—terminate on the aponeurosis of the thigh.

We must reflect the glutæus medius to see the third glutæal muscle beneath it. The line of separation between them is marked by a large branch of the glutæal artery.

47. *Glutæus minimus.*— This muscle arises from the greater part of the surface of the ilium below the upper curved line. Its fibres pass over the capsule of the hip-joint, and converge to a tendon which is inserted into a depression on the front part of the great trochanter. The chief action of this and the preceding muscle is to assist in balancing the pelvis steadily on the thigh, as, *e. g.*, when we are standing on one leg; with the fixed point at the ilium, it is also an abductor of the thigh. But the anterior fibres of the glutæus medius co-operate with the tensor fasciæ in rotating the thigh inwards.

48. *Glutæal vessels and nerves.*— The glutæal artery is the largest branch of the internal iliac. Emerging from the pelvis through the great ischiatic notch above the pyriformis muscle, it at once divides into large branches for the supply of the glutæal muscles. Of these, some proceed forwards between the glutæus maximus and medius; others run in curves between the glutæus medius and minimus, towards the anterior part of the ilium. Many of them inosculate with branches of the external circumflex artery of the thigh.

The nerve which accompanies the glutæal artery is a branch of the lumbo-sacral nerve (see Abdomen, § 71, *a*). It subdivides to supply the glutæus medius and minimus, and the tensor fasciæ; in some subjects it also sends a branch to the glutæus maximus, but this muscle is chiefly supplied by the lesser ischiatic nerve.

A practical surgeon ought, in case of need, to be able to cut down and tie the glutæal artery as it emerges from the pelvis. The following is the best rule for finding it:—The toes are supposed to be turned inwards. A line is drawn from the posterior superior spine of the ilium to the midspace between the tuber ischii and the great trochanter: now the artery emerges from the pelvis at a point where the superior third joins the two inferior thirds of such a line.*

* The operation of tying the glutæal artery was first performed by John Bell.—See his "Principles of Surgery," vol. i. p. 421.

49. We have next to examine the series of small muscles which rotate the thigh outwards—namely, the pyriformis, the obturator internus, with the gemelli attached to it, the quadratus femoris, and the obdurator externus.

50. *Pyriformis.*—This muscle arises from the front surface of the sacrum between the holes for the sacral nerves, and also from the margin of the great sacro-ischiatic notch. The fibres converge to a tendon which is inserted into the upper border of the trochanter major.

51. *Obturator internus.*—This muscle, of which we can at present see very little more than the tendon, arises within the pelvis from all that surface of the ischium between the great ischiatic notch and the obturator foramen, and also from the obturator membrane. The fibres terminate on four tendons which converge towards the lesser ischiatic notch, pass round it as round a pulley, and then uniting into one, are inserted into the inner side of the top of the great trochanter. We ought to divide the tendon about three inches from its insertion, in order to see the four tendons which play over the smooth cartilaginous pulley. As might be expected, there is a large synovial bursa to prevent friction.

52. *Gemelli.*—These muscles are accessory to the obturator internus, and are situated, the one above, the other below it. The gemellus superior arises from the spine of the ischium; the gemellus inferior from the upper part of the tuberosity. Their fibres are inserted into the tendon of the obturator internus.

53. *Quadratus femoris.*—This muscle arises from the prominent ridge on the outer part of the tuber ischii. Its fibres run horizontally outwards, and are inserted into the back of the great trochanter, in a line with the linea aspera. We notice that the lower border of the quadratus femoris runs parallel with the upper edge of the adductor magnus; in fact, it lies on the same plane. Between these muscles is generally seen a terminal branch of the internal circumflex artery.

54. *Obturator externus.*—It is rather difficult to obtain a clear view of this muscle, because it is situated so deeply, and covered by so many others. It arises from the front surface of the bone (pubes and ischium), which circumscribes the inner half, or there-

abouts, of the obturator foramen, and also from the adjoining part of the obturator membrane. The fibres converge to a tendon which runs nearly horizontally outwards over a groove in the ischium, and is inserted into the pit of the great trochanter.

55. *Great Ischiatic nerve.*—This large nerve is formed by the union of the sacral nerves, and is destined to supply the powerful flexor muscles of the lower extremity. Emerging from the pelvis through the ischiatic notch, below the pyriformis, it descends over the external rotator muscles of the thigh, along the interval between the tuber ischii and the trochanter major, but rather nearer to the former, so that, in the sitting position, the nerve is protected from pressure by this bony prominence. The nerve does not descend quite perpendicularly, but rather obliquely forwards, parallel with the great sacro-ischiatic ligament. It does not give off any branches in this early part of its course, except to the quadratus, the gemelli, and the hip-joint; but it is generally accompanied by a branch of the ischiatic artery, called the comes nervi ischiatici.*

a. Lesser Ischiatic nerve.—This is derived from the lower part of the sacral plexus. It leaves the pelvis with the greater ischiatic nerve, but on the inner side of it, and in company with the ischiatic artery. The only muscular branches which it gives off are, two or more, which enter the lower border of the glutæus maximus. All its other branches are cutaneous. One turns round the lower border of the glutæus maximus, and supplies the skin of the buttock (see § 43). Another, called the long pudendal, turns inwards towards the perineum, to supply the skin of that region and the scrotum (see Abdomen, § 45). The continued trunk runs down the back of the thigh, as low as the upper part of the calf, supplying the skin all the way down.

56. *Ischiatic artery.*—This branch of the internal iliac leaves the pelvis below the pyriformis, and then descends between the tuber ischii and the great trochanter, along the inner side of the great ischiatic nerve. It gives off,— 1. Two or more considerable

* The arteria comes nervi ischiatici runs generally by the side of the nerve, but sometimes in the centre of it.

branches to the glutæus maximus. 2. A coccygeal branch, which runs through the great sacro-ischiatic ligament, and then ramifies in the glutæus maximus, and on the back of the coccyx. 3. The comes nervi ischiatici. 4. Branches to the several external rotator muscles. Lastly, branches which supply the upper part of the flexor muscles, and others which inosculate with those of the internal circumflex artery of the thigh.

57. *Pudic artery and nerve.*—The course of this artery and nerve has been fully described in another place (see Abdomen, § 70, *f*). All that we have to observe about them in this dissection is, that they pass over the spine of the ischium, and that in a thin subject it is possible to compress the artery against the spine. The rule for finding it is this: rotate the foot inwards, and draw a line from the top of the great trochanter to the base of the coccyx; the junction of the inner with the outer two-thirds gives the situation of the artery.*

DISSECTION OF THE BACK OF THE THIGH.

58. The incision should be continued down the back of the thigh, the ham, and the upper six inches or thereabouts of the calf; and the skin should be reflected on either side.

59. *Cutaneous nerves.*—The skin at the back of the thigh is supplied by the lesser ischiatic nerve, which runs down beneath the fascia, as low as the upper third of the calf, distributing branches on either side. These, therefore, should be carefully traced.

There are no subcutaneous veins of any size at the back of the thigh, because they would here be liable to pressure. But near the ham we find a subcutaneous vein, called the external saphena. It ascends from the calf, and joins the popliteal vein.

60. *Muscular fascia.*—Respecting this, there is nothing to be said, more than that its fibres run chiefly in a transverse direction,

* Mr. Travers succeeded in arresting hæmorrhage from a sloughing ulcer of the glans penis by pressing the pudic artery with a cork against the spine of the ischium.

that it becomes stronger as it passes over the popliteal space, and that here it is connected with the tendons on either side. We should remove it, in order to examine the powerful muscles which bend the leg, commonly called the hamstring muscles.

61. Hamstring muscles. — There are three of these, and all agree in this respect, that they arise by strong tendons from the tuber ischii. One, the biceps, is inserted into the head of the fibula; while the other two, namely the semitendinosus and semimembranosus, are inserted into the tibia. The divergence of these muscles towards their respective insertions occasions the well-known space termed the ham, which is occupied by soft fat, and the popliteal vessels and nerves.

62. *Biceps.*—This muscle, as implied by its name, has two origins, a long and a short. The long one takes place, by means of a strong tendon, from the back part of the tuber ischii; the short one, by fleshy fibres, from the linea aspera of the femur. This, which we can easily see by dissecting on the outside of the thigh, begins at the linea aspera, just below the insertion of the glutæus maximus, and continues nearly down to the external condyle. It joins the longer part of the muscle, and both terminate on a common tendon, which is inserted into the head of the fibula. The tendon covers part of the external lateral ligament of the knee-joint, and a small bursa intervenes.*

63. *Semi-tendinosus.*—This arises, in common with the biceps, from the back part of the tuber ischii. The fibres terminate upon a long tendon, which spreads out below the knee-joint, and is inserted into the inner surface of the tibia below the tendons of the sartorius and gracilis. Like them, it plays over the internal lateral ligament of the knee-joint, and is provided with a bursa to prevent friction.

64. *Semi-membranosus.* — This muscle arises from the tuber ischii, outside the two preceding, by means of a strong flat tendon which extends nearly half way down the thigh. It forms a bulky muscle which lies on a deeper plane than the others, and is inserted

* It is this tendon which can be so plainly felt as the outer hamstring in our own person.

by a thick tendon into the posterior part of the head of the tibia.* One or two other immediate connections of the tendon will be more conveniently seen hereafter. But we must now observe a large *bursa* which is almost invariably found between it and the inner head of the gastrocnemius, where they rub one against the other. This bursa is generally from one and a half to two inches long; and the chief point of interest concerning it is, that it occasionally communicates with the synovial membrane of the knee-joint, not directly, but through the medium of another bursa beneath the inner head of the gastrocnemius. From an examination of 150 bodies, we infer that this communication exists about once in five instances; and it need scarcely be said that the proportion is large enough to make us cautious in interfering too roughly with this bursa when it becomes enlarged.†

Action of the ham-string muscles.—These muscles produce two different effects, according as their fixed point is at the pelvis or the knee. With the fixed point at the pelvis, it is obvious enough that they can bend the knee; with the fixed point at the knee, they form a very important part of the machinery which keeps the body erect. For instance, if, when standing, we bend the body at the hip, and feel the muscles in question, we find that they are in strong action, in order to prevent the trunk from falling forwards; they, too, are the chief agents concerned in bringing the body again to the erect position. In doing this, they act as levers of the first order; the acetabulum being the fulcrum, the trunk the weight to be moved, and the power at the tuber ischii.

To put the bearing of the muscles of the thigh on the pelvis in

* We shall subsequently find that part of the tendon of the semi-membranosus is covered by the internal lateral ligament of the knee-joint, and that there is a small bursa between them to prevent friction.

† When the bursa in question becomes enlarged, it occasions a fluctuating swelling of greater or less dimensions on the inner side of the popliteal space. The swelling bulges out, and becomes tense and elastic when the knee is extended, and *vice versâ.* As to its shape, it is generally oblong; but this is subject to variety, for we know that the bursæ, when enlarged, are apt to become multilocular, and to burrow between the muscles where there is the least resistance.

the clearest point of view, let us suppose we are standing upon one leg: the bones of the lower extremity represent a pillar which supports the weight of the trunk on a ball-and-socket-joint; the weight is nicely balanced on all sides, and prevented from falling by four groups of muscles. In front, there are the rectus and sartorius; on the inner side, the adductors; on the outer side, the glutæi; and behind, the ham-strings.

The ham-string muscles are supplied with blood by the branches of the profunda, which we observe coming through the tendon of the adductor magnus close to the femur. Their nerves are derived from the great ischiatic.

65. Popliteal space.—Since the ham-string muscles diverge from each other to reach their respective insertions, they leave between them a space, commonly called the popliteal. Now this space is bounded below by the converging origins of the gastrocnemius; its shape may, therefore, be compared to that of a lozenge. It is filled up by a large quantity of fat, which permits the easy flexion of the thigh, and in this fat we find imbedded the popliteal vessels and nerves in the following order: nearest to the surface are the nerves, while the vessels lie close to the bone, the vein being superficial to the artery.

66. *Popliteal nerves.*—If the ischiatic nerve be traced from the buttock, we find that it descends upon the adductor magnus, and that, after being crossed by the long origin of the biceps, it then runs along the outer border of the semi-membranosus. Having given branches to the three great flexor muscles, it divides, about the lower third of the thigh (higher or lower in different subjects), into two large nerves—the peroneal and the proper popliteal.

a. The *peroneal* runs close by the inner side of the tendon of the biceps* towards the head of the fibula, below which we have already traced it (§ 41), dividing into branches for the extensor muscles of the foot and the toes.

b. The proper *popliteal* accompanies the popliteal artery, and is destined to supply the flexor muscles on the back of the leg and the sole of the foot.

* The nerve is therefore very liable to be injured in the operation of dividing the outer ham-string.

By clearing out all the fat, we observe that the popliteal vessels enter the ham through an aperture in the adductor magnus, and descend close to the back part of the femur, and afterwards over the back of the knee-joint. At first they are partially overlapped (at least in muscular subjects) by the semi-membranosus; indeed, the outer border of this muscle is a good guide to the artery in the operation of tying it. With a little care, we may discover two or more absorbent glands, which are situated one on either side of the artery. They deserve attention, because, when enlarged, their close proximity to the artery may give them an apparent pulsation which might be mistaken for an aneurism.

Deferring a more complete description of the course, relations, and branches of the popliteal artery till this vessel is exposed throughout its whole course, we think it advisable to pass on now to the great muscles of the calf.

DISSECTION OF THE CALF.

An incision should be made down the centre of the calf to the heel, and the skin reflected on either side. We have first to examine the cutaneous veins and nerves.

67. *Cutaneous veins and nerves.*—The chief cutaneous vein and nerve of the calf is called the *external* or *posterior saphenous.* The vein commences on the outer side of the foot, runs behind the external ankle, and then up the back of the calf, receiving numerous tributary veins in its course. It eventually passes through the muscular fascia over the popliteal space, and joins the popliteal vein.

a. The corresponding nerve is formed, as it were, by two roots,* —one from the peroneal, the other from the popliteal. The roots generally unite about the middle of the calf, and the single nerve coming through the fascia, descends with the saphenous vein, and is finally distributed to the outer side of the foot and the little toe.

* These two roots are sometimes called respectively the communicans peronei and communicans poplitei.

68. *Muscular fascia.*—Respecting this there is nothing particular to be observed, except that it is attached to the edge of the tibia. We may therefore at once remove it. extensor

69. MUSCLES OF THE CALF.—The great ~~flexor~~ muscle of the foot consists of two portions; the more superficial, called the gastrocnemius, arises from the lower end of the femur, while the deeper, called the soleus, arises from the tibia and fibula. The force of both is concentrated on one thick tendon, commonly called the tendo Achillis, which is inserted into the heel.

70. *Gastrocnemius.*—This muscle arises by two strong tendinous heads, one from the upper and back part of each condyle of the femur. The inner head is the larger, and is, moreover, intimately connected with the tendon of the adductor magnus. The two parts of the muscle descend, distinct from each other, and form the two bellies of the calf, of which the inner is rather the lower. Both terminate, rather below the middle of the leg, on the broad commencement of the tendo Achillis.

We recommend that the gastrocnemius be divided transversely near to its insertion, and reflected upwards from the subjacent soleus, as high as its origin. By this proceeding we observe that the contiguous surfaces of the muscles are covered by a beautiful glistening tendinous expansion, which receives the insertion of their fibres, and transmits their collective force to the tendo Achillis.

We observe also the large sural vessels and nerves which supply each head of the muscle. Moreover, to facilitate the play of the inner tendon over the condyle, there is a bursa, which generally communicates with the knee-joint; and in the substance of the outer tendon is commonly found a small piece of fibro-cartilage. Lastly, between the gastrocnemius and soleus there is the long tendon of the plantaris.

71. *Plantaris.**—This little muscle arises from the rough line just above the outer condyle of the femur. It descends close to the inner side of the outer head of the gastrocnemius, and terminates,

* This is the representative of the palmaris longus of the fore-arm. In man it is lost on the calcaneum, but in monkeys, who have prehensile feet, it is the proper tensor muscle of the plantar fascia.

a little below the knee, in a long tendon, which we trace down the inner side of the tendo Achillis to the calcaneum.

72. *Soleus.*—This muscle arises from the head and the upper third of the posterior surface of the fibula, from the oblique ridge on the back of the tibia,* and also from about the middle third of the inner border of this bone. Descending from this great extent of origin, the fibres swell out beneath the gastrocnemius, and terminate on a broad tendon, which, after gradually contracting, forms a constituent part of the tendo Achillis.

The *tendo Achillis* begins about the middle of the leg, and is at first of very considerable breadth, but it gradually contracts and becomes thicker as it descends. The narrowest part of it is about one inch and a half above the heel; here, therefore, it can be most conveniently and safely divided for the relief of club-foot. There is no risk of injuring the deeper-seated parts, because they are separated from the tendon by a quantity of fat. Its precise insertion is into the under and back part of the os calcis. We observe that the tendon previously expands a little, and that between it and the bone there is a bursa of considerable size.

The obvious *action* of the gastrocnemius and soleus is to raise the body on the toes. But since the gastrocnemius passes over two joints, it has the power (like the rectus) of extending the one while it bends the other, and it is, therefore, admirably adapted to the purpose of walking. For instance, by first extending the foot it raises the body, and then, by bending the knee, it transmits the weight from one leg to the other. Again, supposing the fixed point to be at the heel, the gastrocnemius is also concerned in keeping the body erect, for it keeps the tibia and fibula perpendicular on the foot, and thus counteracts the tendency of the body to fall forwards.

We now pass on to examine the course and relations of the popliteal vessels and nerves.

* The tibial and fibular origins of the soleus constitute what some anatomists describe as the two heads of the muscle. Between them descend the popliteal vessels, protected by a sort of tendinous arch.

73. Course and relations of the popliteal artery.—After passing through the appropriate opening in the tendon of the adductor magnus, the great artery of the lower limb takes the name of popliteal. It then descends nearly perpendicularly behind the knee-joint, and between the origins of the gastrocnemius, as far as the lower border of the popliteus, where it divides into the anterior and posterior tibial arteries. In its descent it lies, first, upon the lower part of the femur, and here it is slightly overlapped by the semimembranosus ; next, it lies upon the posterior ligament of the knee-joint, and lastly upon the popliteus. The vein closely accompanies the artery, and is situated superficially with regard to it, and rather to its outer side in the first part of its course. The popliteal nerve runs also in a similar direction with the vein, but is still more superficial. The vessels and the nerve are surrounded by fat, and we generally find one or more absorbent glands in the immediate neighbourhood of the artery, just above the joint.

74. The *branches* of the popliteal artery are the *articular* and the *sural.*

a. Articular arteries.—There are five of these, specially intended for the supply of the knee-joint, and the articular ends of the bones. The two superior run, one above each condyle, close to the bone ; the two inferior run one beneath each lateral ligament of the joint; and all four proceed towards the front of the capsule. The fifth, called the "azygos," enters the joint through the posterior ligament. These several articular arteries form, over the front and sides of the joint, a beautiful network of vessels, which communicate superiorly with the descending branch of the external circumflex and the anastomotica magna, and inferiorly with the anterior tibial recurrent. It is mainly through these channels that the collateral circulation is established in the leg after a ligature of the femoral artery.

b. The *sural* arteries proceed one to each head of the gastrocnemius, and are proportionate in size to the muscle. One or more branches are distributed to the soleus. These arteries are severally accompanied by branches of the popliteal nerve for the supply of the muscles.

We should now examine more fully the insertion of the semimembranosus into the head of the tibia. We observe, 1. that its tendon is prolonged under the internal lateral ligament of the knee, and that a bursa intervenes between them; 2. that it sends upwards and outwards a ligamentous expansion to protect the back of the knee-joint; and 3. that a fascia proceeds from its lower border, and binds down the popliteus muscle.

75. *Popliteus.*—This muscle arises from a depression on the outside of the external condyle by means of a thick tendon which runs beneath the lateral ligament. The muscular fibres gradually spread out, and are inserted into the posterior surface of the tibia above the oblique ridge observable on this bone. Its action is to rotate the leg inwards. We notice that the tendon plays over the articulation between the tibia and fibula, that a bursa intervenes to prevent friction, and that this generally communicates by a wide opening with the knee-joint.

Reflect the soleus from its origin, and remove it from the deep-seated muscles, observing at the same time the numerous arteries which enter its under surface. This done, we have next to notice the fascia which binds down the deep muscles. It is attached to the margin of the bones on either side, and increases in strength towards the ankle, in order to form a sort of annular ligament to confine the tendons and the vessels and nerves in their passage into the sole of the foot.

76. Deep muscles on the back of the leg.—There are three. 1. the flexor longus digitorum on the tibial side; 2. the flexor longus pollicis on the fibular; and 3. the tibialis posticus upon the interosseous membrane.

77. The *flexor longus digitorum* arises from the posterior surface of the tibia, commencing below the popliteus, and extending to within about four inches of the lower end of the bone. The fibres terminate on a tendon which runs through a groove on the back of the inner ankle, and then entering the sole, divides into four tendons for the four outer toes.

78. The *flexor longus pollicis* is a remarkably powerful muscle. It arises from the lower two-thirds of the posterior surface of the fibula. The fibres terminate on a tendon which runs through a

groove on the back of the astragalus, and thence along the sole to the great toe. The action of this muscle is essential to the propulsion of the body in walking.

79. The *tibialis posticus* is so concealed between the two preceding muscles that we cannot properly examine it without reflecting the flexor longus pollicis. It arises from the interosseous membrane and from more or less of the tibia and fibula. The muscular fibres terminate on a tendon which comes into view a short distance above the inner ankle, and, running through the same groove with the tendon of the flexor longus digitorum, then enters the sole, and is inserted into the scaphoid bone. Its action is to bend and turn the foot inwards.

The precise situation of the tendon of the tibialis posticus is interesting in a surgical point of view, because the tendon has frequently to be divided for the relief of talipes varus. It lies close to, and nearly parallel with, the inner edge of the tibia, so that this is a very good guide to it. Its synovial sheath commences about $1\frac{1}{2}$ inch above the end of the internal malleolus, and is consequently opened in the operation.

80. Course and relations of the posterior tibial artery.—This artery is one of the branches into which the popliteal divides at the lower border of the popliteus. It descends over the deep muscles at the back of the leg to the interval between the internal malleolus and the os calcis, and, entering the sole, divides into the external and internal plantar arteries. It lies first upon the tibialis posticus, and then on the flexor longus digitorum; but behind the ankle it is in contact with the tibia, so that here it can be felt beating during life, and effectually compressed. In the upper part of its course we observe that it runs nearly midway between the bones, and that it is covered by the great muscles of the calf: to tie it, therefore, in this situation is very difficult. But in the lower part of its course it gradually approaches the inner border of the tibia, from which, generally speaking, it is not more than $\frac{1}{2}$ or $\frac{3}{4}$ inch distant. Here, being comparatively superficial, it may be easily tied. Immediately behind the internal malleolus, we find it between the tendons of the flexor longus digitorum, on the inner side, and the flexor longus pollicis on the outer. It has

two venæ comites, which communicate at intervals. Its branches are as follows:—

a. Numerous unnamed branches to the soleus and the deep muscles.

b. The *peroneal* is a branch of very considerable size, and often as large as the posterior tibial itself. Arising about $1\frac{1}{2}$ inch below the division of the popliteal, it descends close to the inner side of the fibula, and then over the articulation between the tibia and fibula to the outer part of the os calcis, where it inosculates with the malleolar and plantar arteries. We observe that all down the leg it is embedded among the muscles: for it is covered first by the soleus, and afterwards by the flexor longus pollicis. To both these muscles, but to the latter especially, it sends numerous branches, and just above the ankle it gives off a constant one, which runs in front of the tibio-fibular articulation, and inosculates with the other malleolar arteries.

81. *Posterior tibial nerve.*—This is the continuation of the popliteal. It descends close to its corresponding artery, and, entering the sole of the foot, divides into an external and internal plantar nerve. Respecting its precise position with regard to the artery, we have only to observe, that in the first part of its course the nerve lies superficial to the artery, and rather to its inner side; but behind the ankle the nerve lies on the outer side of the artery, and on the same plane.* Respecting its branches, we need only observe that they supply the three deep-seated muscles.

DISSECTION OF THE SOLE OF THE FOOT.

82. A perpendicular incision should be made down the middle of the sole, and the skin should be reflected on either side. We have to notice the peculiar structure of the subcutaneous tissue. It is composed of globular masses of fat, separated by strong fibrous septa, and forms a sort of elastic pad. This is especially marked

* It sometimes happens that the nerve divides into its two plantar branches higher than usual, and then we find that one lies on either side of the artery.

at the heel, and at the ball of the great and the little toe, these being the points which form the tripod supporting the arch of the foot.

In removing the subcutaneous tissue from the ball of the great and the little toe, we often meet with bursæ, simple or multilocular. They are generally placed between the skin and the sesamoid bones, and have remarkably thick walls. Very frequently we trace an artery and nerve running directly through one of these sacs, and this explains the acute pain produced by their inflammation.

83. *Cutaneous nerves.*—The skin of the heel is supplied by a considerable branch of the posterior tibial nerve, and the remainder of the sole by small branches of the plantar nerves which come through the fascia, just as they do in the palm of the hand.

84. *Plantar fascia.*—This, as one might expect, is remarkably dense and strong. In a general way it may be said that it extends from the under and back part of the os calcis to the distal ends of the metatarsal bones; and that it forms for the arch of the foot, as it were, a floor, which not only protects the plantar vessels and nerves, but is also one among the many structures which support the arch itself. It acts like the string of a bow. We see this exemplified in some cases of distortion, where an unnatural contraction of the plantar fascia makes the arch of the foot too convex, and it is necessary to divide the fascia in order to relieve the deformity.

The particular arrangement of the fascia is just like that in the palm. The central part, where there is the greatest strain, is beyond all comparison stronger than the lateral parts, which merely serve as sheaths for the respective muscles of the great and little toe. Near the distal ends of the metatarsal bones it divides into five portions; each of these subdivides into two slips, which embrace the corresponding flexor tendons, and are then finally attached to the metatarsal bones and their connecting ligaments. Between the primary divisions of the fascia,—that is, in a line between the toes, we trace the digital vessels and nerves.

In the interdigital folds of the skin, there are also ligamentous fibres, which run from one side of the foot to the other, and answer the same purpose as the analogous ones in the hand.

The plantar fascia must be partially removed in order to examine the muscles. In doing this, we soon discover that towards the os calcis its removal is not accomplished without some difficulty, because the muscles arise from it.

85. SUPERFICIAL MUSCLES.—After the removal of the fascia, three muscles are exposed. All arise from the os calcis and the fascia, and proceed forwards to the toes.* The central one is the flexor brevis digitorum; the lateral are, respectively, the abductor pollicis, and the abductor minimi digiti. Let us examine the lateral muscles first.

86. *Abductor pollicis.*—This muscle arises from the inner and back part of the os calcis, and from the internal annular ligament. Its origin arches over the plantar vessels and nerves in their passage into the sole. The fibres run along the inner side of the sole, and terminate on a tendon which is inserted into the inner side of the base of the first phalanx of the great toe.

87. *Abductor minimi digiti.*—This muscle has a very strong origin from the under surface of the os calcis, and also from its external tubercle. Some of its fibres terminate on a tendon which is inserted into the proximal end of the metatarsal bone of the little toe; but the greater part run on to a tendon which is inserted into the outer side of the first phalanx of the little toe.

88. *Flexor brevis digitorum.*—This muscle arises from the under surface of the os calcis, between the two preceding. It passes forwards, and divides into four tendons, which run superficial to those of the long flexor. If we cut open the sheath which contains them, and follow them on to the toes, we find that each bifurcates over the first phalanx, so as to allow the long tendon to pass, and then the two slips, re-uniting, are inserted into either side of the second phalanx. In fact, just the same arrangement prevails as in the fingers.

We must now detach the three superficial muscles from the os calcis, and remove them from the sole, leaving them, however, connected to the toes, so that they can be replaced if necessary. This

* They are separated from each other by strong perpendicular partitions, proceeding from the fascia.

done, we have a full view of the plantar vessels and nerves, of the long flexor tendon of the great toe, and of the long flexor tendon of the other toes, as well as its accessory muscle.

89. *Tendon of the flexor longus digitorum. Musculus accessorius.*—Tracing this tendon into the sole, we find that an accessory muscle is attached to it. The muscle arises from the inner side of the os calcis, and it has often a second tendinous origin from the outer side of the bone. Its fibres run straight forwards, and are inserted into the fibular side of the tendon, so that their action is not only to assist in bending the toes, but also to make the common tendon pull in a straight line towards the heel, which, from its oblique direction, it would not do without this accessory muscle. The common tendon then divides into four, one for each of the four outer toes. These run, as before observed, in the same sheath with the short tendons, and after passing through them are inserted into the base of the ungual phalanx. Respecting the manner in which the tendons are confined by fibrous sheaths, and lubricated by a synovial lining, what was said of the fingers applies equally to the toes.

a. Lumbricales.—These are four little muscles, placed between the long flexor tendons. Each, excepting the most internal, arises from the adjacent sides of two tendons, proceeds forwards, and then sinking between the toes, terminates in an aponeurosis which joins the extensor tendon on the dorsum of the toes.

90. In the next place let us trace the long flexor tendon of the great toe. From the groove in the astragalus it runs along the groove in the lesser tuberosity of the os calcis, and then straight to the base of the last phalanx of the great toe. We observe that it crosses the long flexor tendon of the toes, and that the two tendons are generally connected by an oblique slip, so that we cannot bend the other toes without the great toe.

91. Plantar arteries and nerves.—The posterior tibial artery, having entered the sole between the origins of the abductor pollicis, divides into the external and internal plantar arteries. To understand the course and relations of each, it is necessary to replace all the reflected muscles in their proper position.

a. The *internal plantar* artery is a very small one: it passes

forwards between the abductor pollicis and the flexor brevis digitorum to the interval between the first and second toes, where it terminates in small inosculations with the digital arteries. Its chief use is to supply the muscles between which it runs.

b. The *external plantar* is the principal artery of the sole, and alone forms the plantar arch. It runs obliquely outwards across the sole towards the base of the fifth metatarsal bone, and then, sinking deep from the surface, bends inwards across the bases of the metatarsal bones, and inosculates with the anterior tibial in the first interosseous space. In the first or oblique part of its course, it lies between the flexor brevis digitorum and the flexor accessorius; in the second or transverse part it lies very deep beneath the flexor tendons, and the adductor pollicis muscle,—in fact, close to the metatarsal bones. Deeply seated as it appears at first sight to be, a part of its curve near the fifth metatarsal bone lies immediately beneath the fascia. Here it might be more easily tied than in any other part of its course.

Its chief branches are the four digital arteries, which arise in the arched part of its course. They supply both sides of the fifth, fourth, third, and the outer side of the second toe; the great toe, and the inside of the second, being supplied, we remember, by the dorsalis hallucis. Concerning the distribution of the digital arteries, we must refer to the account given of the analogous arteries in the hand; for they are in all respects similar.

Besides the digital arteries, the arch gives off small branches, which ascend between the metatarsal bones and inosculate with the dorsal interosseous arteries.

92. *Plantar nerves.*—The posterior tibial nerve divides, like the artery, into an external and internal plantar. The *internal* division is generally the larger, and supplies nerves to three toes and a half, like the median nerve in the palm. It also supplies the muscles on the inner side of the sole. The *external* plantar supplies nerves to the fifth toe and the outer side of the fourth, like the ulnar in the palm. Besides these, however, it furnishes nerves to the abductor minimi digiti, and the flexor accessorius, and a considerable branch which accompanies the plantar arch for the supply of the adductor pollicis and the interossei.

93. Deep muscles.—Having traced the principal vessels and nerves, we must divide them with the flexor tendons near the os calcis, and turn them down towards the toes, so as fairly to expose the deep muscles in the sole. These are, the flexor brevis and the adductor pollicis, the flexor brevis minimi digiti, the transversalis pedis, and the interossei.

94. *Flexor brevis pollicis.*—This muscle arises from one or more of the cuneiform bones, generally the internal. It proceeds along the metatarsal bone of the great toe, and divides into two portions, which run one on either side of the long flexor tendon, and are inserted by tendons into the sides of the first phalanx of the great toe. In each tendon there is a large sesamoid bone. These bones not only increase the strength of the muscle, but both together form a sort of pulley for the free play of the long flexor tendon.

95. *Adductor pollicis.*—This very powerful muscle arises from the cuboid bone and the ligamentous covering of the long peroneal tendon. Passing obliquely across the foot, it is inserted into the outer side of the base of the first phalanx of the great toe. It is obvious that this muscle greatly contributes to support the arch of the foot.

96. *Flexor brevis minimi digiti.*—This little muscle arises from the base of the fifth metatarsal bone, proceeds forwards along it, and is inserted into the base of the first phalanx of the little toe.

97. *Transversalis pedis.*—This slender muscle runs transversely across the distal ends of the metatarsal bones. It arises by little fleshy slips from the four outer toes, and is inserted into the first phalanx of the great toe with the adductor pollicis.

98. *Interossei.*—These muscles are arranged nearly like those in the palm; that is to say, they occupy the intervals between the metatarsal bones, and are seven in number, four being on the dorsal aspect of the foot, and three on the plantar. They arise from the sides of the metatarsal bones, and terminate in tendons which are inserted, some into the inner, others into the outer side of the first phalanges of the toes and their respective extensor tendons. Their use is to draw the toes to or from each other, and they do this or that according to the side of the phalanx on which they act.

Now, if we draw an imaginary longitudinal line through the second toe, we find that all the dorsal muscles draw *from* that line, and the plantar *towards* it. This is the key to the action of them all. A more detailed account of these muscles is given in the dissection of the palm.

It now only remains to trace the tendons of the peroneus longus and the tibialis posticus. The tendon of the peroneus longus is the deepest in the sole. We find it running through a groove in the cuboid bone obliquely across the sole towards its insertion into the outer side of the base of the metatarsal bone of the great toe. The tendon is confined in a strong fibrous sheath, which is lined throughout by synovial membrane.

The tendon of the tibialis posticus may be traced over the internal lateral ligament of the ankle, and thence under the head of the astragalus to the scaphoid bone into which it is chiefly inserted. One or two slips are sent off to the cuneiform bones. We observe that the tendon greatly contributes to support the head of the astragalus, and that for this purpose it often contains a sesamoid bone.

DISSECTION OF THE LIGAMENTS.

99. Ligaments of the pelvis.—The sacrum is united to the last lumbar vertebra in the same manner as one vertebra is to another. The same observation applies to the union between the sacrum and the coccyx. We therefore refer the reader to the description of the ligaments of the spine.*

The innominate bones are connected to each other in front, constituting the pubic symphysis; and posteriorly to the sacrum or the spine, constituting the sacro-iliac symphysis. These symphyses, as well as their connecting ligaments, we will separately examine.

100. *Pubic symphysis.*—This is secured by 1. an anterior ligament, consisting of oblique and transverse fibres; 2. a posterior

* See the end of the Dissection of the Head and Neck.

ligament, less distinct; 3. a sub-pubic ligament, or ligamentum arcuatum: it is remarkably strong, and rounds off the point of the pubic arch; 4. an intermediate fibro-cartilage. If we make a perpendicular section through it, we observe that it consists of concentric layers, and that its general structure resembles that between the bodies of the vertebræ.

101. *Sacro-iliac symphysis*.—This is secured by 1. ligamentous fibres in front; 2. ligamentous fibres much more marked, and collected in bundles behind; 3. a very strong ligament called the ilio-lumbar, which extends from the transverse process of the last lumbar vertebra to the crest of the ilium; 4. the greater sacro-ischiatic ligament, one of enormous strength, which extends from the sacrum and coccyx to the tuberosity of the ischium; and 5. the lesser sacro-ischiatic, which extends from the sacrum and coccyx to the spine of the ischium. Both these last not only connect the bones, but also, from their great breadth, contribute to block up the lower aperture of the pelvis.

Even supposing all the above ligaments be divided, we still find that the ilium adheres most firmly to the sacrum. If they be forcibly separated, it is then seen that they are connected in front by a layer of cartilage, of which the shape is not unlike that of the ear, and behind by strong ligamentous fibres, the surfaces to which they were attached being left rough and bare.

102. LIGAMENTS OF THE HIP-JOINT.—This joint is secured by the very form of the bones, and by the great strength of the many powerful muscles which surround it. Being a perfect ball and socket, so far as the mere bones are concerned, one might suppose that it would admit of universal motion, but it is not so; for we shall presently find that the disposition of its ligaments is such as to restrict its range of motion to those directions only which are most consistent with the maintenance of the erect attitude, and the general requirements of this part of the skeleton.

The most important ligament, and that which presents the most interesting peculiarities, is the *capsular*. It is attached, on the one hand, to the circumference of the acetabulum at a little distance from the margin, and, on the other, to the base of the neck

of the femur: but observe, this is the case in front of the neck only; for the under and back part is merely embraced by the capsule like a collar; in fact, just like the head of the radius is embraced by the annular ligament. Moreover, we perceive that the capsule is not of uniform strength and thickness throughout. It is exceedingly thick and strong over the front of the joint, and answers the purpose of a ligament or strap extending from the upper and outer part of the acetabulum down to the base of the neck of the femur. What is the object of all this? When the thigh is moved forwards, the capsule is necessarily relaxed, and rotation is free enough; but when the bone is moved backwards, the capsule is put on the stretch, and offers an irresistible impediment to any movement in this direction beyond what is essential to the erect attitude.

By laying open the capsule, we have an opportunity of ascertaining the enormous thickness of it in front, and the strong hold it has upon the bones. This proceeding also exposes the cotyloid ligament, or what may be called the sucker of the acetabulum.

The *cotyloid* ligament is a piece of fibro-cartilage which is attached all round the margin of the acetabulum. Its use is sufficiently apparent. It not only deepens the cavity, but gradually shelves off, so as to embrace the head of the femur like a sucker. It necessarily extends over the notch at the lower part of the acetabulum, and just in this situation has received the name of the transverse ligament.

The *ligamentum teres* is exposed by drawing the head of the femur out of the socket. It is attached, on the one hand, to the borders of the acetabular notch; and, on the other, to the fossa in the head of the femur. We observe that the nature of its attachments is such as to prevent the head of the femur from being moved out of its socket in any but a downward direction; consequently it must be torn in all dislocations of the hip, excepting into the foramen ovale. To prevent pressure on the ligament, and to allow free room for the play of it, we notice, in the dry bones, that there is a gap at the bottom of the acetabulum, and a small groove on the head of the femur. These parts, respectively, not being subject to friction, are not crusted with cartilage like the other surfaces of the bone, but are occupied by a soft yielding fat.

The use of the ligamentum teres is to assist in steadying the pelvis on the thigh in the erect position. In this position, the direction of the ligament is vertical, and it is quite tight. Consequently it prevents the pelvis from rolling towards the opposite side, or the thigh from being adducted beyond a certain point. But, when the thigh is at all bent, the ligament is relaxed, and we can easily cross the leg.

Thus, then, it is evident that the ligaments of the hip are so arranged, that when we stand at ease on one leg, the pelvis is spontaneously throw into a position in which its range of motion is the most restricted; for the capsule prevents it from rolling backwards, and the ligamentum teres from inclining beyond a certain point towards the opposide side. This arrangement economises muscular force in the balancing of the trunk.

Respecting the synovial membrane of the hip, we have to observe that it covers the neck of the thigh-bone to a greater extent in front than behind, and that it is reflected over the ligamentum teres.

Lastly, it is easy enough to ascertain that the head of the thigh-bone is kept in the acetabulum by atmospheric pressure; and the amount of this is, of itself, sufficient to keep the limb suspended from the pelvis, even supposing all muscles and ligaments to be divided. When fluid is effused into the hip-joint, the influence of the atmospheric pressure is diminished in proportion; and the corresponding surfaces of the bones being no longer maintained in accurate contact, it sometimes happens that the head of the femur escapes from its cavity, giving rise to what is called a spontaneous dislocation.

103. Ligaments of the knee-joint.—If we look at the skeleton only, one would be apt to suppose that the knee-joint were very insecure. But nature has amply made up for this apparent insecurity by powerful ligaments, and by surrounding the joint on all sides with a thick capsule formed by the tendons of the muscles which move it.

Let us first examine the tendons concerned in the construction of the *capsular* ligament. In front there is the ligamentum patellæ;

on either side are the tendons of the vasti; and at the back of the joint no less than four tendons contribute to form the capsule,—namely, the tendons of the gastrocnemius, the tendon of the semi-membranosus, and of the popliteus.* It deserves to be noticed that the weakest part of the capsule is near the tendon of the popliteus: here, therefore, matter formed in the popliteal space may possibly make its way into the joint, or *vice versâ.*

Exclusive of the capsule, the proper ligaments of the joint are—1st, the lateral; and 2, the crucial in the interior.

The *internal lateral* ligament is a broad flat band, which extends from the inner condyle to the inner side of the tibia, a little distance below its head. A few of the deeper fibres are attached to the inner semilunar cartilage, and serve to keep it in place. In the performance of the several motions of the joint, there is a certain amount of friction between the ligament and the head of the tibia, and consequently we find a small bursa interposed.

The *external lateral* ligament is a strong round band which extends from the outer condyle to the head of the fibula. In some instances there is a smaller band a little deeper, called the short external lateral ligament.

If the fibrous capsule be removed from the sides of the joint, we observe that a quantity of loose cellular tissue intervenes between it and the proper synovial capsule. In this tissue, more particularly on the inner side of the knee, are often found one or more bursæ of considerable size. But they very rarely communicate with the interior of the joint.

In the next place, the joint should be opened above the patella. We then observe the great extent of the fold which the synovial membrane forms above this bone.† The object of it is to allow the free play of the bone over the lower part of the femur. The fold extends a little higher above the inner than the outer condyle, and this accounts for the form of the swelling produced by effusion into the joint.

* This ligamentous expansion over the back of the joint is commonly called the "ligamentum posticum Winslowii."

† In performing operations near the knee, the joint should always be bent in order to draw the synovial fold as much as possible out of the way.

Below the patella, we observe that a slender band of the synovial membrane proceeds backwards to the space between the condyles. It is commonly called the *ligamentum mucosum*, and the edges of it on either side are called the *ligamenta alaria*. These, in point of fact, are not true ligaments, but merely the remnants of the partition, which, in the early stage of the joint's growth, divided it into two lateral halves.

Immediately outside the synovial membrane there is always more or less fat, and this is especially accumulated under the ligamentum patellæ. Its use is obviously to fill up vacuities, and to mould itself according to the several movements of the joint.

The *crucial* ligaments, so named because they cross like the letter X, extend from an appropriate excavation on the mesial side of each condyle to the head of the tibia. The anterior passes from the outer condyle forwards to the front interval between the articular surfaces of the tibia. The posterior is best seen from behind, after the fibrous capsule is removed. It passes from the inner condyle backwards to the hinder interval between the articular surfaces of the tibia.

Inter-articular fibro-cartilages.—Between each condyle and the corresponding articular surface of the tibia, we observe that there is an incomplete ring of fibro-cartilage. They answer many important purposes. They deepen the articular surfaces of the tibia; their mobility and elasticity enables them to adapt themselves so as to correspond with the condyles in the several movements of the joint; they distribute pressure over a greater surface, upon the principle that a porter places a knot on his shoulder to carry his load with greater ease; and lastly, they deaden the jarring of the bones. To these several uses they are admirably adapted by their shape, the mode in which they are fixed, and their general construction. Their surfaces are covered by synovial membrane to prevent friction. They are the thickest at the circumference, and gradually shelve off to a thin margin. Their form is suited to that of the respective condyles, the inner being oval, and the outer circular.* The ends of each are firmly attached in appropriate

* Their form may be compared to the letter C, but the ends of the outer cartilage are nearer together than those of the inner.

excavations in the middle line of the head of the tibia; those of the inner cartilage being more remote from the centre. Besides this, they are mutually connected in a front by a thin *transverse* ligament; and their circumference is also connected to the head of the tibia by fibrous tissue, yet not so closely as to restrict their necessary range of motion.* Lastly, the external cartilage is more or less connected with the crucial ligaments.

Action of the ligaments.—In the extended position all the ligaments are completely on the stretch; rotation, however slight, is impossible, and the joint forms part of a firm unyielding column for the support of the body. A cursory glance at the respective attachments of the ligaments shows that this cannot be otherwise, because their centre of motion is placed so near to the back part of the condyles of the femur.

But in the bent position the lateral ligaments are relaxed, and permit a rotatory movement of the tibia to the extent of 40°. This movement is chiefly in an outward direction (for it is unnatural to turn the leg inwards), and it is effected, not by a rotation of the tibia on its own axis, but by a rotation of the outer head of the tibia round the inner. A little examination soon shows that the tension of the ligaments is adapted accordingly; for those attached to the inner condyle of the femur are comparatively tight, whereas those of the external are quite lax.†

104. LIGAMENTS CONNECTING THE TIBIA AND THE FIBULA.—There is a distinct joint between the upper ends of the tibia and

* Of the two cartilages the external has the greater freedom of motion, because in rotation of the knee the outer side of the tibia moves more than the inner. Consequently, it is not in any way connected to the lateral ligament: so far from this, it is separated from it by the tendon of the popliteus, of which the play is facilitated by a bursa communicating freely with the joint. For this reason the external cartilage is more liable to dislocation.

† If both crucial ligaments only be divided, the joint in the extended state is tolerably firm: not so in the bent state. But the reverse holds good if the lateral ligaments only be divided: in this case the bones in the bent state are tightly connected; but, when extended, the tibia rolls outwards, and untwists the crucial ligaments.

fibula, although it admits of but little movement. It is firmly secured by oblique ligaments in front and behind. The contiguous surfaces of the bones are crusted with cartilage. In the great majority of instances its synovial membrane is independent; but we now and then do meet with cases in which it communicates with the synovial membrane of the knee.

The shafts of the bones are connected by the interosseous membrane. But the chief purpose of this is to afford additional surface for the attachment of muscles. Its component fibres cross each other like the letter X, and have openings here and there for the passage of blood-vessels.

The lower ends of the tibia and fibula are most firmly connected, for it is obviously essential to the solidity of the ankle-joint that there be no motion between them. They are, therefore, secured by an oblique ligament in front and behind, and by strong ligamentous fibres which connect their contiguous surfaces, and answer the purpose of rivets. Besides these, we find that a strong fibro-cartilaginous ligament proceeds from the end of the fibula, and is attached along the posterior border of the articular surface of the tibia. The object of it is to deepen the excavation of the tibia, and enable it to adapt itself more accurately to the articular surface of the astragalus.

105. LIGAMENTS OF THE ANKLE-JOINT. — From the very form of the bones, it is obvious that the ankle is a hinge joint; consequently, like all others of the kind, its chief security depends upon the great strength of its lateral ligaments. At the same time the hinge is not so perfect but that it admits of a slight rotatory motion, of which the centre is on the fibular side, and therefore the reverse of that in the case of the knee.

The *internal lateral* ligament, sometimes called, from its shape, "deltoid," is exceedingly thick and strong, and makes up for the comparative shortness of the malleolus on this side. The great strength of it is proved by the fact, that in dislocations of the ankle inwards, the summit of the malleolus is more likely to be broken off than the ligament to be torn. It arises from a deep excavation on the inner side of the malleolus, radiates from this point, and is inserted into the side of the astragalus, and also into the os calcis,

and the scaphoid bone. In consequence of their being inserted wide of the axis of the hinge, its component fibres are not equally tight in all the motions of the joint. By moving the foot backwards and forwards, we see that the anterior fibres limit extension, and the posterior flexion of the ankle.

The external lateral ligament consists of three entirely distinct parts,—an anterior, a posterior, and a middle. All three arise from an excavation near the summit of the external malleolus; the two first are inserted, respectively, into the front and the back of the astragalus; while the middle one is inserted into the os calcis.

The closure of the joint is completed, in front and behind, by a thin capsular membrane attached to the bones near their respective articular surfaces, and sufficiently loose to permit the necessary range of motion.

We have said that, besides flexion and extension, the construction of the ankle-joint admits of a very slight rotatory movement in a horizontal direction, the centre being on the fibular side. In adaptation to this movement the internal malleolus is made much shorter than the outer; it is not so tightly confined by its ligaments, and its articular surface is part of a cylinder.

By laying open the joint, we have an opportunity of observing that the breadth of the corresponding articular surfaces of the bones is greater in front than behind: the object of this is to render the tibia less liable to be dislocated forwards over the astragalus. Whenever this happens, the astragalus must of necessity become firmly locked between the malleoli.

106. Ligaments connecting the bones of the foot.—The astragalus is the key-stone of the arch of the foot, and supports the whole weight of the body. It articulates with the os calcis and the os scaphoides in such a manner as to permit the abduction and adduction of the foot, so useful in the direction of our steps. We must carefully examine this for ourselves, since no mere verbal description can do the subject justice.

The astragalus articulates with the os calcis by two distinct surfaces, respecting which it is necessary to remark, that the

anterior is slightly convex, and the posterior slightly concave. This adaptation of itself contributes much to prevent the separation of the bones. But their principal bond of union is a very strong *interosseous* ligament which occupies the interval between them.

In the skeleton we observe that the head of the astragalus articulates in front with the os scaphoides, but that a part of the head is unsupported below. What, then, supports it here in the perfect foot? An enormously strong and elastic ligament (*calcaneo-scaphoid*), which extends from the os calcis to the os scaphoides. These bones, together with the ligament, form a complete socket for the reception of the head of the astragalus; and it is this joint, and not the ankle, which permits the abduction and adduction of the foot. But the chief peculiarity about the ligament just alluded to is its elasticity. It acts in all respects like a spring, and allows to the key-stone of the arch a certain amount of play, which is obviously of great service in preventing concussion of the body. Whenever this ligament loses its elastic property, as is often the case with those who are in the habit of carrying heavy burdens, the arch of the foot gradually yields, and the individual becomes flat-footed.

The os calcis articulates with the os cuboides pretty nearly on a line with the articulation between the astragalus and the os scaphoides. The bones are most firmly connected by means of a powerful ligament in the sole, called the *calcaneo-cuboid,* or ligamentum longum plantæ. Some of its fibres extend forwards as far as the third and fourth metatarsal bones.

It would be only tedious repetition to enumerate individually the several ligaments which connect the remaining bones of the tarsus and metatarsus. Let it, then, suffice to say that they are firmly braced together by very strong ligaments, both on their dorsal and their plantar surfaces, and by interosseous ligaments which extend between their contiguous surfaces, like so many rivets. Though there is very little motion between any two bones, the collective amount is such that the foot is enabled to adapt itself the more accurately to the ground, pressure is more equally distributed, and consequently there is a firmer basis for the support of the body.

Being composed, moreover, of several pieces, each of which possesses a certain elasticity, the foot gains a general springiness and solidity which could not have resulted from a single bone.

Exclusive of the ankle-joint and the phalanges of the toes, the bones of the foot are provided with six distinct synovial membranes,—namely,

a. Between the posterior articular surface of the astragalus and os calcis.

b. Between the head of the astragalus and the bones composing its socket.

c. Between the os calcis and the os cuboides.

d. Between the inner cuneiform bone and the metatarsal bone of the great toe.

e. Between the three cuneiform and the adjoining bones (the great toe excepted).

f. Between the os cuboides and the fourth and fifth metatarsal bones.

The phalanges of the toes are connected in all respects like those of the fingers. See, therefore, the description given in the dissection of the hand.

END OF PART III.

THE DISSECTION OF THE BRAIN.

The most convenient manner of removing the brain is to cut through the scalp, across the top of the head, from one ear to the other, so that the anterior part of the scalp may be detached from the skull and pulled down over the face, and the posterior part over the back of the head. The skull-cap should then be taken off on a plane about half an inch above the supra-orbital ridges. It is better to saw only through the outer table of the skull, and to break through the inner with a chisel. In this way, the dura mater and the brain are least likely to be injured.

Previous to the examination of the brain itself we shall give an account of the structure and uses of the three membranes by which it is surrounded,—namely, the dura mater, the arachnoid membrane, and the pia mater.

Dura mater.—The first membrane exposed after the removal of the skull-cap is the dura mater; so called from the fanciful notion that it gave rise to all the other membranes in the body. It is remarkably tough and fibrous, and should be considered rather as the lining membrane of the skull-cap than as a proper investment of the brain. It adheres very closely to the cranial bones, and serves as their internal periosteum; for this reason it is more difficult to separate the skull-cap from it in early life, while the bones are in active growth, than in mature age. Numerous arteries ramify between the skull-cap and the dura mater; and the course of the chief branches may be distinctly traced by the grooves which they make in the bones. These arteries are very liable to be injured in fractures of the skull; and hence it is that extravasation of blood between the skull and the dura mater is one of the common causes of compression of the brain.

Of the arteries which ramify between the dura mater and the

skull-cap, the principal is the *arteria meningea media,* a branch of the internal maxillary (Head and neck, § 82). Entering the skull through the foramen spinosum, it winds along a deep groove in the sphenoid, and the anterior inferior angle of the parietal bones, to the top of the skull, giving off branches in all directions. It is accompanied by two veins. The other meningeal arteries are of insignificant size. The *anterior* come from the æthmoidal branches of the ophthalmic artery; the *posterior* proceed from the occipital and the ascending pharyngeal branches of the external carotid, and enter the skull through the foramen jugulare.

Besides being the internal periosteum of the skull, the dura mater serves other important purposes. It forms partitions within the cranium, so as to support the lobes of the brain, and prevent their pressing on each other. These partitions cannot be properly seen without destroying the brain; it is better, therefore, to examine them in a dry skull, such an one as every anatomical museum contains. There are three of them: two are vertical, and separate the two hemispheres of the cerebrum and those of the cerebellum; while the third is nearly horizontal, and supports the posterior cerebral lobes.

The great vertical partition proceeding from the dura mater into the interior of the skull is named, from its resemblance to the blade of a sickle, the *falx cerebri.** It divides the cerebrum into two symmetrical hemispheres—a right and a left. It begins in a point attached to the crista galli, and gradually penetrates deeper as it extends backwards. From its base or broadest part there proceeds the horizontal partition, named the *tentorium cerebelli.* This forms a kind of membranous arch for the support of the posterior cerebral lobes, so that they may not press upon the cerebellum beneath them. We observe that the tentorium is attached to the transverse ridge of the occipital bone, to the petrous part of the temporal, and to the posterior clinoid processes of the sphenoid.

* The falx cerebri is sometimes deficient, and then there is no division of the cerebrum into hemispheres. See a case recorded by Mr. Carlisle, in "Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge," vol. i. p. 212.

The little partition which separates the lobes of the cerebellum is called the *falx cerebelli.* It is placed vertically in the same line with the falx cerebri, and its point is attached to the edge of the foramen magnum.

Sinuses of the dura mater.—It is one of the peculiarities of the cerebral circulation that the blood is returned through canals or sinuses formed by the dura mater. These canals are produced by a separation of the two layers* of which the dura mater is composed, together with a corresponding groove on the inside of the skull. They are lined by the same smooth membrane as the rest of the venous system. Since their walls consist of such unyielding structure, and are always on the stretch, it is obvious that they are admirably adapted to resist the pressure of the brain. There are about fifteen of these sinuses, and all eventually discharge their blood through the internal jugular veins. Their arrangement will be best understood by referring to a dried preparation in which they are injected with coloured wax. Their names and position are as follows :—

The *superior longitudinal sinus* runs along the upper edge of the falx cerebri. It begins very small at the crista galli, gradually increases in size in its course backwards, and opposite the tubercle of the occipital bone divides into the right and left lateral sinuses, the right being in general the larger. Besides the numerous veins from the cancellous texture of the skull-cap, the superior longitudinal sinus receives large veins from each hemisphere of the cerebrum. It is interesting to observe that these veins run from behind forwards, contrary to the current of blood in the sinus, and that they

* The dura mater consists of two layers united by cellular tissue ; of these, the external one forms the internal periosteum of the bones of the skull. In the vertebral canal the separation between the two layers is perfect ; but, at the foramen magnum, the spinal dura mater and the periosteum of the vertebral canal meet together, so as to form in the skull but a single membrane. In some animals, where the thickness of the bones constituting the cranial arch is very remarkable, as in some of the whale tribe, the external layer of the dura mater is exceedingly vascular. See some observations by Dr. Knox, in the Lancet of the 19th October, 1839.

pass through the wall of the sinus very obliquely, not unlike the ureter does into the bladder. The probable object of this oblique entrance is to prevent regurgitation of blood from the sinus into the veins of the brain.

If we cut open the superior longitudinal sinus, we observe that it is triangular, and that its cavity is intersected in many places by slender fibrous cords, termed "*cordæ Willissii.*"* Their precise use is not understood.

In the neighbourhood of the superior longitudinal sinus we generally meet with small whitish granulations, sometimes lying singly, sometimes in clusters. These are termed "*glandulæ Pacchioni.*"† They are found in three distinct situations:—1, on the outside of the dura mater, and often so large as to occasion depressions in the bones; 2, on the surface of the pia mater; 3, in the interior of the longitudinal sinus, covered by its lining membrane. Their size, number, and appearance differ in different subjects. Nothing is determined concerning their precise nature; but it is presumed that they are morbid products, since they are never observed in very young subjects.

The *lateral sinuses* are the two great sinuses through which all the blood from the brain is returned into the internal jugular veins. Their course is well marked in the dry skull. The right is commonly the larger. Each proceeds at first horizontally outwards, inclosed between the layers of the tentorium, along a groove on the occipital bone and the inferior angle of the parietal; it then descends along the mastoid portion of the temporal bone, and again indenting the occipital, turns forwards to the foramen lacerum posterius, and terminates in the internal jugular vein.‡

* So called after our countryman Willis, who first described them in his work De Cerebri Anatome, 1664.

† After the Italian anatomist, who first described them in 1705. These bodies would appear to originate in the subarachnoid cellular tissue, whence they, in their growth, either perforate the dura mater and hollow out the bones, or make their way into the longitudinal sinus.

‡ It has in some subjects another outlet, through the foramen mastoideum, or else the posterior condyloid foramen.

The *inferior longitudinal sinus* is of small size, and sometimes absent. Strictly speaking, it is not a sinus, but rather a small vein inclosed in the lower edge of the falx cerebri. It terminates in the straight sinus at the anterior margin of the tentorium.

The *straight sinus* may be considered as the continuation of the preceding. It runs along the line of junction of the falx cerebri with the tentorium cerebelli, and terminates at the divergence of the two lateral sinuses. It receives the two "vena Galeni" which return the blood from the lateral ventricles of the brain.

The *cavernous sinus,* so called because its interior is intersected by numerous bands, giving it a cellular appearance, extends along the side of the body of the sphenoid bone, just outside the internal carotid artery. It receives the ophthalmic vein, which leaves the orbit through the foramen lacerum orbitale. The cavernous sinuses on each side communicate through two small sinuses which extend transversely, the one in front of, the other behind the pituitary fossa. Collectively, they form what is called the *circular sinus.*

The *petrosal sinuses* lead from the cavernous to the lateral. There are two on each side. The superior runs along the upper edge of the petrous bone ; the inferior along the suture between the petrous and the occipital bones.

The *transverse sinus* extends from the one inferior petrosal to the other, across the basilar process of the occipital bone.

The *occipital sinuses* are two in number, and very small. They run along the attached edge of the falx cerebelli, and open into the divergence of the lateral sinuses.*

Arachnoid membrane.—It is this second investment which forms the smooth surface of the brain exposed after the removal of the

* The meeting of the several sinuses opposite the spine of the occipital bone is commonly termed the "*torcular Herophili,*" after the celebrated anatomist who first described it. It is a kind of triangular reservoir, with the base below, and presents six openings—namely, that of the superior longitudinal sinus, those of the two lateral and of the two occipital, and that of the straight sinus. The term "*torcular*" is an incorrect version of the original word σωλῆν (a canal or gutter), employed by Herophilus.

dura mater; and it is named arachnoid from the great tenderness and delicacy of its tissue, which give it a resemblance to a spider's web. It is a serous membrane, and, like all others of the kind, forms a closed sac, one part of which, called the parietal layer, lines the under surface of the dura mater; the other, called the visceral, covers the surface of the brain. The inner surface of this serous* membrane is perfectly smooth, and lubricated by sufficient moisture to prevent friction, since the brain is alternately rising and falling with a slight pulsating movement, caused in part by the action of the heart, and in part by the process of respiration. The parietal layer is of such extreme tenuity that it can only be demonstrated in very early life: indeed, it consists of little more than a layer of epithelium; but the visceral layer is sufficiently obvious. We observe that it is colourless and transparent, and that it is spread uniformly over the surface of the brain, without insinuating itself between the convolutions, or entering the ventricles. On account of its extreme tenuity, and its close adhesion to the pia mater, it cannot be readily separated from this membrane; but there are certain parts at the base of the brain where the arachnoid membrane can be seen quite distinct from the subjacent tunic.

Pia mater.—This is the immediate investing membrane of the brain. It is extremely vascular: indeed, it consists of little else than the minute ramifications of arteries connected by cellular tissue; so that it forms a stratum in which the blood-vessels may divide and subdivide before they enter the brain.† If we attempt to remove it from the surface we find that it sinks down to the bottom of all the convolutions; and, in the further dissection of the brain, it will be seen that this membrane penetrates into

* Mr. Rainey considers that the arachnoid membrane consists of a tissue of ganglionic nerves. See his paper in the Medico-Chirurgical Transactions, vol. xxix. p. 85.

† It is one of the protective provisions of the circulation in the delicate substance of the brain, that the arteries break up into small ramifications on the surface before they penetrate its interior. When carefully injected, it is seen that the blood-vessels of the pia mater form minute angular spaces, from which the vessels pass off at right angles into the brain.

the lateral ventricles for the supply of their interior, forming what is called the "velum interpositum" and the "choroid plexus."

Sub-arachnoid space and fluid. — We have said that the arachnoid membrane is separated in certain situations from the pia mater by a watery fluid contained in the meshes of very delicate cellular tissue. Such interspaces are termed sub-arachnoid. There is one of these in the longitudinal fissure of the cerebrum, because the arachnoid does not go quite down to the bottom of it, but passes across below the edge of the falx, at a little distance above the corpus callosum. Again, at the base of the brain there are many such,—*e. g.*, between the pons Varolii and the commissure of the optic nerves, across the fissure of Silvius, and between the cerebellum and the medulla oblongata. In the examination of the spinal cord, too, it will be seen that there is a considerable interval between the arachnoid and the pia mater, also occupied by fluid. The purpose of this fluid is sufficiently obvious; it not only fills up space like fat does in other parts, but mechanically protects the nervous centres from the violent shocks and vibrations to which they would otherwise be liable.

GENERAL DIVISION OF THE BRAIN, AND NOMENCLATURE OF ITS DIFFERENT PARTS.

The collective mass of nervous matter, designated under the common term brain, completely fills the cavity of the skull. It is divided, in a general way, into three parts—the *cerebrum*, or intellectual brain, which occupies the whole of the upper part of the cranial cavity; the *cerebellum*, or little brain, which occupies the lower and back part beneath the tentorium; and the *medulla oblongata*, by much the smallest portion, situated at the base beneath the cerebellum. This last part passes out of the skull through the foramen magnum, and is continuous with and forms the commencement of the spinal cord.

The cerebrum, in man, is so much more developed than the other parts of the brain, and so completely overlays them, that

nothing but itself is seen when the skull-cap and dura mater are removed. It is of an oval form, with the broad end towards the back of the head. It is divided, in the middle line, by a deep longitudinal fissure, into two equal halves, technically termed the right and left hemispheres.* This fissure, we remember, is occupied by the falx cerebri. The surface of each hemisphere presents a number of tortuous eminences, termed "the convolutions," separated from each other by so many furrows or *sulci*, which respectively correspond to the depressions and ridges observable in the cranial bones. Many of these furrows are occupied by the larger veins in their course to the sinuses; others are filled by sub-arachnoid fluid. In old age, or in cases of disease where the convolutions are shrunk and atrophied, this fluid sometimes accumulates in considerable quantity, giving rise to the "watery brain." The convolutions themselves are merely folds of the brain for the purpose of increasing the extent of surface upon which may be laid the grey or vesicular nerve substance, now generally admitted to be the source of power. They are not precisely alike on both sides. Their number, disposition, and depth, vary a little in different individuals, and, to a certain extent, may be considered as an index of the degree of intelligence.†

The under surface of each cerebral hemisphere is not only convoluted like the upper, but presents in addition three lobes, which

* Examples are now and then met with where the longitudinal fissure is not exactly in the middle line; the consequence of which want of symmetry is, that one hemisphere is larger than the other. Bichat (Recherches Physiologiques sur la Vie et la Mort, Paris 1829) was of opinion that this anomaly exercised a deleterious influence on the intellect. It is a remarkable fact that the examination of his own brain after death so far went to prove the error of his own doctrine.

† Those who wish to investigate the cerebral convolutions in their simplest form in the lower classes of mammalia, and to trace them through their successive complications and arrangement into groups as we ascend in the higher classes, should consult M. Leuret, Anatomie Comparée du Système Nerveux considerée dans ses Rapports avec l'Intelligence, Paris 1839; also M. Foville, Traité de l'Anat. du Système Nerveux, &c., Paris, 1844.

fit into the base of the skull. The anterior lobe rests upon the roof of the orbit, and is separated from the middle one by a cleft called the *fissure of Sylvius,* which receives the lesser wing of the sphenoid bone. The middle lobe occupies the middle fossa of the skull formed by the sphenoid and temporal bones. The posterior lobe rests on the arch of the tentorium. Between this and the preceding there is no evident boundary; so that some anatomists, among whom may be mentioned the illustrious Haller, enumerate only two lobes.*

Nomenclature of the parts seen at the base of the brain.—We must now examine the several objects seen at the base of the brain in the middle line, proceeding in order from the back part. In this description let it be understood that we omit the cerebral nerves. These, with the disposition of the great arteries at the base, will be more conveniently examined hereafter.

Immediately above the medulla oblongata is a square protuberance called the "*Pons Varolii.*" This is the commissure which connects the two lobes of the cerebellum, and it is received into the basilar groove of the occipital bone. From the anterior border of the pons two round cords of nervous matter, about half an inch thick, diverge from each other,—one towards each hemisphere of the cerebrum. These are the *crura cerebri.* Winding round the outer side of each crus is seen a white band—the *tractus opticus,* or root of the optic nerve. These tracts converge, and, uniting in the middle line, constitute the *commissure of the optic nerves.* Between the crura cerebri the surface is perforated by a number of blood-vessels; hence this spot is called the "*locus perforatus posticus,*—posticus, as contra-distinguished from another part of the brain's base presenting similar perforations, situated at the root of

* By separating the middle from the anterior lobe, may be recognised, deep in the fissure of Silvius, what is called the *island of Reil.* It is merely a portion of the under surface of the hemisphere, mapped out by a number of small and deep convolutions, which dove-tail, as it were, with those adjoining. It corresponds with the extra-ventricular part of the corpus striatum, and might, therefore, be called the lobule of that ganglion.

the fissure of Sylvius, and called the "*locus perforatus anticus.*"* In front of the locus perforatus posticus are two small round white bodies, called the "*corpora mammillaria* or *albicantia:*" in front of these again there is a simple elevation of the surface, consisting of grey matter, called the "*tuber cinereum,*" upon which the commissure of the optic nerves seems, as it were, to ride. From the tuber cinereum, and just behind the optic commissure, a conical tube, of a reddish colour, termed the "*infundibulum,*" descends to the pituitary gland which occupies the sella turcica of the sphenoid bone. In front of the optic commissure the tuber cinereum is continued forwards under the form of a thin grey layer (*lamina cinerea*) so as to join the anterior end of the corpus callosum. Now these several objects—namely, the locus perforatus posticus, mammillary bodies, tuber cinereum, infundibulum, and lamina cinerea—collectively constitute the floor of the third ventricle of the brain. Lastly, by gently separating the anterior lobes of the cerebrum, we discover the anterior extremity of the corpus callosum, or great commissure which connects the two hemispheres of the cerebrum.

Examination of the interior.—Let the brain be laid upon its base and properly supported on the sides. We have already said that the hemispheres of the cerebrum are divided by a deep longitudinal fissure. By gently separating the hemispheres, we observe at the bottom of this fissure a white band of nervous matter: this is called the "*corpus callosum,*" and is the great transverse commissure of the cerebrum.

The next proceeding is, to slice off the hemispheres down to the level of the corpus callosum. The cut surface presents a mass of white substance surrounded by an undulating layer of grey matter of about one-eighth of an inch thick. Since this grey matter forms a sort of bark round the white, it is often called the cortical sub-

* The large number of arteries which enter the brain in these respective situations are destined to supply the two great masses of grey matter in the interior—namely, the optic thalamus and the corpus striatum. The former corresponds with the locus perforatus posticus, the latter with the locus perforatus anticus.

stance.* We should notice the depth of the furrows between the convolutions: they penetrate generally to about one inch; but their depth varies in different individuals: hence it follows that two brains of apparently equal size may yet be very unequal in point of extent of surface of the grey matter, and therefore in amount of power. To the unassisted eye the cortical layer appears to be made up entirely of grey substance; but with the aid of a microscope it may be seen to consist of six layers,—three of grey alternating with three of white.†

Corpus callosum.‡—This is a transverse portion of white sub-

* There are two kinds of nervous matter—the grey or vesicular, and the white or fibrous. The grey is exceedingly vascular, and contains the nerve-vesicles, which are generally allowed to be the source of power. The white consists of extremely delicate nerve-fibres, is very scantily provided with blood-vessels, and is probably the mere conductor of power.

The intense vascularity of the grey matter has been demonstrated by Mr. Quekett and Mr. Smee, who have had the kindness to allow the author to inspect their beautiful preparations. Mr. Smee's injections were made by using a solution of carmine in ammonia mixed with size. The minute arteries enter the surface of the grey matter, and break up in it into a network of fine capillaries. These capillaries are peculiar in being quite naked, and not supported, as in other parts, by cellular tissue. Hence it is they are so liable to give way, and allow their contents to escape: hence it is they are fenced round by so many provisions calculated to break the force of the current of the blood—namely, the tortuosities of the arteries at the base of the brain, their subdivisions in the pia mater, and the peculiar arrangement of the sinuses.

† These six layers cannot always be demonstrated. Sometimes there are only four, and they are commonly more manifest in the posterior lobes. The external layer is always white. For an account of them, and the best mode of examining them, see Baillarget, Recherches sur la Structure de la Couche Corticale des Circonvolutions du Cerveau, insérées dans les Mémoires de l'Académie de Médecine, 1840.

‡ In a brain properly hardened by spirit the fibres may be traced congregating towards the corpus callosum from both hemispheres: hence they were called by Gall the *converging* fibres of the brain. This anatomist applied the above name to all commissural fibres. Those fibres, on the other hand, which ascended from the medulla oblongata into the hemispheres, he named the *diverging*. Anat. et Physiol. du Système Nerv.: Paris, 1810.

stance which connects the two hemispheres, and is the principal commissure of the cerebrum. We observe that it is about four inches long, and rather nearer to the front than to the back part of the brain. Its surface is not flat, but slightly arched from before backwards. One or more longitudinal ridges, called by the old anatomists the "*raphé*," run along the middle of it. In a fresh brain we can evidently see the transverse fibres of which the commissure is composed extending between the hemispheres; these are the "*lineæ transversæ*" of the old anatomists.

The anterior part of the corpus callosum turns downwards and backwards, forming a bend called its knee, towards the base of the brain. Becoming gradually narrower, it is connected, by means of the lamina cinerea, with the tuber cinereum, with which parts we are already familiar. The posterior part of the corpus callosum terminates in a thick round border, under which the pia mater enters into the interior of the ventricles. We cannot obtain a satisfactory view of the arch formed by the corpus callosum, of its terminations in front and behind, and of the relative thickness of its different parts, without making a perpendicular section through a fresh brain.*

Lateral Ventricles.—Let us proceed in the next place to examine two cavities called the lateral ventricles, and situated, one in each hemisphere of the brain, beneath the corpus callosum. For this purpose a longitudinal incision should be made on each side, about half an inch from the raphé of the corpus callosum. We should be careful not to cut too near the middle line, in order to preserve the delicate partition which descends from the under surface of the corpus callosum, and separates the ventricles from each other. We soon come into these cavities, and, by means of a director, they should be fully laid open. We shall first describe

* The corpus callosum is more or less developed in all mammalia, but is absent in birds, reptiles, and fish. It is not absolutely essential to the exercise of the intellect, for it has been found absent in the human subject without any particular intellectual deficiency. See cases recorded by Reil, Archiv. für die Phys. t. xi.; and Wenzel, de Penitior Struct. Cereb. p. 302.

their mode of origin and general form, and then the names of the several objects seen in them.

The lateral ventricles are two cavities in the general mass of the brain, occasioned by the enormous enlargement and folding backward of the cerebral lobes over the other less developed constituent parts of the central nervous axis. They contain a serous fluid, which, even in a healthy brain, sometimes exists in considerable quantity, but, when preternaturally accumulated, constitutes one form of the disease termed hydrocephalus. The very delicate lining membrane which secretes this fluid is quite distinct from the arachnoid on the outside of the brain, and the epithelium on the surface of it is provided with cilia, of which the vibratile movement may be distinctly seen, especially in the embryo.

With regard to the general shape of the ventricles; they may be rudely compared to two crescents with their backs to each other. Each ventricle extends into the three lobes of which the cerebral hemisphere is composed. That part which extends into the anterior lobe is called the *anterior horn,* and we observe it slightly diverges from its fellow on the opposite side. The *posterior horn** may be traced into the posterior lobe; this rather converges than not to its fellow. The *middle horn,* which runs into the middle lobe, descends towards the base of the brain, making a very curious curve, something like a ram's horn,—that is, in a direction backwards, outwards, downwards, forwards, and inwards. We can easily follow its windings by cutting through the substance of the middle lobe.

Supposing the roof of the lateral ventricles—in other words, the corpus callosum—be removed, what have we to remark on the floor of their interior? Beginning from the front, we notice—1. A grey

* The posterior horns are not always equally developed in both hemispheres, and sometimes they are absent in one or in both. They are only found in the brain of man and the quadrumana.

In the carnivora, ruminantia, solipeda, pachydermata, and rodentia, the lateral ventricles are prolonged into the largely developed olfactory lobes. This is the case in the human fœtus only at an early period.

elevation, of a pyramidal form, called the *corpus striatum.* 2. Behind this, a white elevation called the *thalamus opticus:* of this we at present only see a part. 3. Along the boundary line between the corpus striatum and the thalamus opticus there runs a slender, transparent, horn-like substance, called the *tænia semicircularis.* 4. On the back part of the thalamus opticus there is a red fringe called the *choroid plexus.* It is formed by foldings of the pia mater continued into the ventricles. 5. Immediately behind, and nearly parallel with the choroid plexus, lies the thin white edge or free border of the *fornix.* 6. In the middle or descending horn we find that the choroid plexus runs down to the base of the brain; and there is also a columnar eminence which stands out in relief on the back part of the cavity; to this the fanciful term "*hippocampus major*" has been applied.* 8. In the posterior horn there is a smaller elevation of the surface called the "*hippocampus minor.*" These hippocampal elevations are nothing more than deep convolutions which project into the ventricles. By cutting through the white matter on their surface, we soon come to the cortical substance of the brain.

Having thus far only learned the mere names of the parts in the lateral ventricles, we must now consider them a little more in detail, and also the transparent septum (septum lucidum) by which the two lateral ventricles are separated.

The *corpus striatum* is so called, because, when cut into, it is seen to consist of alternate layers of white and grey matter.† It is a much larger mass of grey substance than it appears to be, for only

* The lower end of the hippocampus major is somewhat expanded and indented on the surface, so as to resemble the paw of an animal. Hence the name given to it, "*pes hippocampi.*"

† The white lines in the corpus striatum are produced by the fibres of the crus cerebri, which traverse this mass of grey matter before they expand to form the hemisphere. The grey matter itself is sometimes called the anterior cerebral ganglion. It is found in all mammalia, in birds, and, to a certain extent, in reptiles; but its precise function is still unknown.

a portion of it projects into the ventricle, cropping out, as it were, on the surface. What we do see of it looks pear-shaped, with the large end forwards: it tapers gradually to a point as we trace it backwards on the outside of the optic thalamus. The under part of the corpus striatum corresponds with the convolution at the base of the brain known as the island of Reil, and also with the locus perforatus anticus,—a spot, we remember, at the root of the fissure of Silvius, so called on account of the number and size of the blood-vessels which pass in there to supply the mass of grey matter in question.

The *tænia semicircularis* is a narrow semi-transparent band of white fibres, which skirts the posterior border of the corpus striatum. In front it is connected with the anterior crus of the fornix, and behind it is lost in the middle horn of the lateral ventricle. Its precise connections, however, are often indistinct, and are still unsettled by anatomists.

Septum lucidum.—This is a thin and almost transparent partition, which descends vertically from the under surface of the corpus callosum, and separates the lateral ventricles from each other. The better way to obtain a perfect view of the attachments and the extent of the septum would be to make a vertical section on one side of it; but we can see it tolerably well by lifting up what remains of the corpus callosum. It is attached below to an arch of white nervous matter, called the fornix. It is not of equal depth throughout. The broadest part is in front, and corresponds with the downward bend or knee of the corpus callosum. It grows gradually narrower behind, and altogether disappears at the back part of the ventricles, where the corpus callosum or upper arch, and the fornix or lower arch, become continuous. This variation, then, in the depth of the septum lucidum arises from the arching downwards of the anterior part of the fornix. However thin and delicate it appears, yet the septum consists of two layers which inclose a space called the fifth ventricle. Each layer is made up of white substance inside, and of grey outside; the little ventricle between them is closed in the adult, and lined by a delicate serous membrane, which secretes in it a minute quantity of fluid; but in fœtal life it

communicates with the third ventricle between the pillars of the fornix.*

We may now cut transversely through the corpus callosum and the septum lucidum, and turn forwards the anterior half. In this way the ventricle of the septum will probably be apparent. By turning back the posterior half of the corpus callosum we obtain a pretty good view of the fornix. But this last proceeding requires care, or the fornix will be reflected at the same time, since these two layers or arches of nervous matter are here so closely connected.

Fornix.—This, as implied by its name, is a layer of white matter arranged in the form of an arch from before backwards, beneath the corpus callosum. It is not of equal breadth throughout, but is somewhat triangular, with the base behind. This broad part is inseparably connected to the corpus callosum. From its anterior narrower part proceed two round white cords, called its anterior crura, close together,—one on either side the mesial line. They do not extend as far forwards as the corpus callosum, but turn nearly vertically downwards to the base of the brain, where they may be traced, one into each of the little white bodies known as the corpora mammillaria. Immediately behind and below these anterior crura we observe that there is an aperture in the middle line through which the choroid plexuses of opposite sides are continuous with each other. This aperture is called the "*foramen of Monro.*"† Strictly speaking, it is not a foramen, but only a communication existing between the two lateral and the third ventricles. If we reflect the posterior half of the fornix, which is done easily enough, since it lies unattached over the velum interpositum, we observe that from each angle of the base there is continued a thin white band, which runs along, and is intimately connected with, the concave side of the hippocampus major: to this band the name of

* The development of the septum lucidum commences about the fifth month of fœtal life, and proceeds from before backwards *pari passu* with the corpus callosum and fornix.

† Monro, Microscopic Enquiries into the Nerves and Brain. Edinburgh, 1780.

"*tænia hippocampi*" is applied; besides which, it is sometimes called the posterior crus of the fornix.*

Velum interpositum and choroid plexus.—Supposing the fornix removed, the velum interpositum, which supports it, is fully exposed. This is nothing more than a portion of the pia mater of the brain which penetrates into the ventricles through the fissure beneath the posterior border of the corpus callosum and fornix.† The shape of this vascular veil is like that of the fornix itself, and its borders are rolled up so as to form the red fringe called the "*choroid plexus.*" These plexuses consist almost entirely of the tortuous ramifications of minute arteries.‡ In front they communicate uninterruptedly with each other across the middle of the brain, through the foramen of Monro; and behind they descend with the middle horns of the lateral ventricles, and become continuous with the pia mater at the base of the brain, between the middle lobe of the cerebrum and the crus cerebri. Down the centre of the veil we observe the two large veins called "*venæ Galeni,*" which return the blood from the ventricles into the straight sinus.

The velum interpositum, with the choroid plexus, must now be carefully reflected in order to expose the following parts:—1. There is a full view of the thalamus opticus. 2. Between the thalami optici there is a deep vertical fissure, precisely in the middle line: this is the *third ventricle of the brain.* 3. Behind the fissure is the *pineal gland,* a very vascular body, about the size of a pea. From the gland we trace forwards two slender white cords, called its peduncles,—one along the inner side of each optic thalamus.

* The fornix and septum lucidum are absent in fish; they are merely rudimentary in reptiles and birds: but all mammalia have them in greater or less perfection, according to the degree of development of the cerebral hemispheres.

† The great fissure beneath the fornix, where the pia mater enters the ventricles, is called the *transverse fissure of the cerebrum.* It extends downwards on each side to the base of the brain.

‡ In preparations where the choroid plexus is well injected, we see that they are covered with beautiful vascular villi. The villi themselves are covered with epithelium.

4. Immediately behind the pineal gland are four elevations, two on each side, called the *corpora quadrigemina* or *nates and testes*. 5. These bodies are connected to the cerebellum by two flat bands, one on each side, termed the *processus a cerebello ad testes*. Between the bands extends a thin translucent layer of grey substance, called the *valve of Vieussens*. Beneath this valve lies the fourth ventricle. Lastly, there are three commissures connecting the opposite sides of the brain.—Let us now examine these objects in detail.

Thalamus opticus.—This is the somewhat square elevation seen on the floor of the lateral ventricle immediately behind the corpus striatum. Though covered with white matter on the surface, yet, if we cut into its interior, we find that it consists of alternate layers of white and grey matter, just like the corpus striatum.* The under surface of the thalamus forms the roof of the descending or middle horn of the lateral ventricle. Beneath the posterior part of the thalamus are two small rounded eminences, termed respectively the "*corpus geniculatum internum, and externum*."†

Third ventricle.—This is the narrow fissure which exists between the optic thalami, and reaches down to the base of the brain. Its boundaries are rather complicated and indefinite, but may be stated as follows:—The roof is formed by the velum interpositum; the floor by certain parts at the base of the brain—namely, the locus perforatus posticus, corpora mammillaria, tuber cinereum, with the in-

* The elevation called the optic thalamus is occasioned by the interposition of a quantity of grey matter among the fibres of the crus cerebri. Gall termed it the inferior ganglion of the cerebrum, in opposition to the corpus striatum, which he termed the superior ganglion (Anat. et Phys. du Système Nerv., Paris, 1810.) The epithet "optic" applied to the thalamus might lead us to suppose that it presides over vision; but that it exercises very little influence over sight is rendered probable by comparative anatomy, by experimental physiology, and by pathology.

† The slight eminences, termed "*corpora geniculata*," are produced by small accumulations of grey matter beneath the surface. A narrow band of white matter connects the external one with the nates, and a similar band connects the internal one with the testes. These bands are faintly marked in man, but more apparent in the lower animals.

fundibulum, commissure of the optic nerves, and lamina cinerea. In front it is bounded by the anterior crura of the fornix, and behind it communicates with the fourth ventricle through a long canal beneath the corpora quadrigemina.

Commissures.—If we gently separate the optic thalami in a very fresh brain, we find that they are connected by a transverse layer of grey matter of rather more than half an inch in breadth. This is the middle commissure: it is sometimes called the soft, on account of its delicate consistence; and in most brains it is generally torn before we have the opportunity of examining it.* The optic thalami are, besides this, connected by a round white cord, called the *posterior commissure.* It is situated immediately in front of, and rather below the pineal gland. The corpora striata are connected by another round white cord, called the *anterior commissure:* it lies immediately in front of the anterior crura of the fornix. If this commissure were properly traced, we should find that it extends transversely quite through the corpus striatum of each side, and then arching backwards, its fibres are lost near the surface of the middle cerebral lobe.

The *pineal* gland is a very vascular heart-shaped body, with the broad part forwards, situated immediately in front of the corpora quadrigemina. It has two white peduncles or crura, which extend forwards, one on the inner side of each optic thalamus, and terminate by joining the crura of the fornix. Its interior contains some calcareous particles, consisting chiefly of phosphate of lime. Although the pineal gland is found in all mammalia, birds, and reptiles, in the same typical position, yet its functions are entirely unknown.

Tubercula quadrigemina.—These are four rounded eminences, situated, two on either side, behind the pineal gland. They are

* The soft commissure does not appear to be a very essential constituent part of the brain. It is not found before the ninth month of fœtal life; and in some instances, according to our observation, is never developed. The brothers Wenzel state that it is absent about once in seven subjects (De penitiori Struct. Cerebri Hom. et Brut. Tubingen, 1812).

white on the surface, but contain grey matter in the interior: this grey matter is accumulated here for the purpose of giving origin to the optic nerves. For this reason a more appropriate term for them would be the "optic lobes," instead of the vulgar name of "nates and testes," handed down from the old anatomists.*

Superior crura of the cerebellum or processus a cerebello ad testes.—By gently drawing back the cerebellum we observe two broad white cords, which pass backwards, slightly diverging from each other, from the corpora quadrigemina to the cerebellum. These are the superior crura of the cerebellum, and constitute the connecting medium between the cerebrum and the cerebellum. Between them extends a thin semi-transparent layer of grey matter, which covers the fourth ventricle. This layer is commonly called the valve of Vieussens, and from it the fourth nerve arises by several filaments.

Iter a tertio ad quartum ventriculum.—The third ventricle is connected with the fourth by means of a canal just large enough to admit a probe, which runs backwards beneath the posterior commissure and the corpora quadrigemina. This passage, together with the third and fourth ventricle, are persistent parts of the central canal, which, in early fœtal life, extended all down the back of the spinal cord.

The *fourth ventricle* is a cavity situated between the cerebellum and the posterior part of the medulla oblongata and pons Varolii. It is, properly speaking, a dilated portion of the primordial axis canal. To obtain a perfect view of its boundaries one should make a vertical section through the parts concerned. But in an ordinary dissection it is sufficient to make a vertical incision in the middle line through the cerebellum and the valve of Vieussens; then, by

* Eminences homologous to the corpora quadrigemina are found in all vertebrate animals: they are the meso-cephalic lobes: they invariably give origin to the optic nerves, and their size bears a direct relation to the power of sight. They are relatively smaller in man than in any other animal. In birds there are only two eminences, and these are very large, especially in those far-seeing birds which fly high, as the eagle, falcon, vulture, &c., who require acute sight to discern their prey at a distance.

widely separating the cut surfaces, the cavity of the fourth ventricle will be laid open. In a vertical section it appears triangular, and its boundaries are as follows :—The front or base is formed by the medulla oblongata and pons Varolii ; the upper wall by the valve of Vieussens and superior crura of the cerebellum ; the posterior wall by the cerebellum itself, and the continuation of the arachnoid membrane on to the back of the spinal cord. The pia mater is prolonged for a short distance into the interior of the cavity, and forms what is called the choroid plexus of the fourth ventricle.*

On the anterior wall of the fourth ventricle,—that is, on the back of the medulla oblongata and the pons,—there are several objects to be noticed. 1. A median furrow, the remains of the primitive axis canal. 2. From the lower part of the furrow two white cords (the *restiform columns* or *inferior crura cerebelli*) pass off from the medulla oblongata, diverging from each like the branches of the letter V, and enter the lateral lobes of the cerebellum. The divergence of these cords with the median furrow was called by the old anatomists the "*calamus scriptorius.*" 3. The floor of the fourth ventricle is covered by grey matter, which is nothing more than the grey substance of the spinal cord exposed by the divergence of its posterior or restiform columns. On its surface we remark a variable number of transverse white lines, some of which form part of the origin of the auditory nerves.

Cerebellum.—This portion of the brain is situated in the occipital fossa of the skull, beneath the posterior lobes of the cerebrum, from which it is separated by the tentorium. In man it is more completely overlapped by the cerebrum than in any other animal. Its form is somewhat elliptical, with the broad diameter transverse. When the arachnoid membrane and the pia mater are removed, we observe that its surface is not arranged in convolutions

* Tiedemann proposes to call the fourth ventricle the first ; because, in the fœtus, it is formed sooner than any of the others ; because it exists in all vertebrated animals, whereas the lateral ventricles are absent in all osseous fishes ; and because the ventricle of the septum lucidum is absent in all fishes, in reptiles, and in birds.

like that of the cerebrum, but that it is laid out upon a plan beautifully adapted to produce a much greater superficial extent of grey matter. It consists, in fact, of a multitude of thin plates or layers, disposed in a series of concentric curves, with the concavity forwards. By a little careful dissection it is easy to separate some of the plates from each other, and it will then be seen that the intervening fissures increase in depth from the centre towards the circumference of the cerebellum. The fissure at the circumference itself is the deepest of all, and nearly horizontal, so that it seems to divide the cerebellum into an upper and a lower segment.

The upper surface of the cerebellum is elevated into a ridge along the middle line, called the *superior vermiform eminence.* Comparative anatomy proves that this is really the fundamental part of the cerebellum. The sides, commonly called the *hemispheres,* are merely offsets or wings, superadded for special purposes, and increase in size as we ascend in the vertebrate series, till in man they form by far the largest part of the organ. They are separated posteriorly by a perpendicular fissure, which receives the falx cerebelli.

On the under surface of the cerebellum its division into the two hemispheres is clearly perceptible. The deep furrow between them is called "the *valley,*" the front part of which is conveniently occupied by the medulla oblongata. In order, therefore, to examine the surface of the valley, we must raise and turn forwards the medulla oblongata, and then widely separate the hemispheres from each other, so as fairly to expose all the objects they overlap. Along the middle line of the valley, then, we observe the *inferior vermiform eminence,* which is, in point of fact, the under surface of the fundamental part of the cerebellum. Traced forwards, this eminence terminates in a tongue-like body, called the "*uvula;*"* traced

* From either side of the uvula may be traced a thin valve-like fold of white substance, which proceeds in a semicircular direction to the little pneumogastric lobes. These folds are called the semicircular valves, or "*valves of Tarini,*" by whom they were first pointed out. (Advers. Anat. prima, Paris, 1750.)

backwards, it terminates in a small conical projection, called the "*pyramid.*"

Moreover, each hemisphere presents on its under surface certain secondary lobes, to which fanciful names have been applied. For instance, that portion which immediately overlays the side of the medulla oblongata is called the tonsil-like lobe *(amygdala)*: it is in the deep valley between these lobes that the uvula lies. Again, at the most anterior part of each hemisphere, and nearest to the middle line, is a little lobe called the "*flocculus,*" or pneumo-gastric lobe.

To examine the internal structure of the cerebellum, a longitudinal section should be made through the thickest part of one of the hemispheres. There is then seen in the centre a large nucleus of white matter, from which branches radiate into the grey substance in all directions. Each of these branches corresponds to one of the plates of the cerebellum, and from it other smaller branches proceed and again subdivide. This racemose appearance of the white matter in the substance of the grey has been likened to the branches of a tree deprived of its leaves, and is generally known as the "*arbor vitæ;*" and it is a beautiful contrivance for bringing an extensive surface of the two kinds of nervous matter into connection with each other.

In the centre of the white nucleus of each hemisphere there is an oval space, circumscribed by a zigzag line of grey matter. To this the name *corpus dentatum* or *rhomboideum* has been given. It is displayed both by a vertical and by a horizontal section.

The cerebellum is connected with the cerebro-spinal axis as follows:—With the medulla oblongata, by means of the restiform or sensory tracts of nervous matter: these are sometimes called its inferior crura;—with the cerebrum, by means of the processus a cerebello ad testes: these are called its superior crura. The transverse fibres of the pons are said to constitute the middle crura.

Respecting the function of the cerebellum, the arguments furnished by comparative anatomy render probable that it is a co-ordinator of muscular movements,—as, *e. g.*, in the action of walking, flying, swimming, &c.

Pons Varolii or *tuber annulare.*—This is a convex eminence, situated at the base of the brain, immediately above the medulla oblongata, and supported by the basilar groove of the occipital bone. In its antero-posterior diameter it measures rather more than one inch. Down the middle of it runs a furrow which lodges the basilar artery. If the pia mater be carefully removed from its surface, we see clearly that its fibres proceed transversely from one hemisphere of the cerebellum to the other: hence it is called the commissure of the cerebellar lobes. Throughout the mammalia its size bears a direct ratio to the degree of development of these lobes; therefore it is larger in man than in any other animal.* But it should be understood that only the superficial fibres are transverse: if these be turned off, we then see that the anterior fibres of the medulla oblongata run under them at right angles into the crura cerebri, like a river under the arch of a bridge.

Besides the transverse and longitudinal fibres just described, the pons, when cut through, is seen to contain in its interior a large quantity of grey matter, which probably gives origin to fresh nerve-fibres: so that it would appear reasonable to consider the pons as a source of power, as well as a mere conductor of it.

MEDULLA OBLONGATA.—The term medulla oblongata is applied to that part of the cerebro-spinal axis which follows immediately below the pons Varolii, and is directly continuous with the upper end of the spinal cord. It is one of the most important divisions of the nervous system, since it gives origin to the nerves which preside over speech, respiration, and digestion. It is about an inch and a quarter long, and is supported upon the basilar groove of the occipital bone, so that it descends from the brain obliquely backwards to the foramen magnum. We remember that its posterior surface is received into the fossa between the hemispheres of the cerebellum. Its form is somewhat pyramidal with the base superiorly; from thence it gradually tapers into the spinal cord.

* Birds, reptiles, and fishes, have no pons, because there are no lateral lobes to the cerebellum.

The anterior surface of the medulla oblongata presents, when the pia mater is removed, a deep median fissure continuous with that of the cord. Just below the pons Varolii this fissure terminates in a kind of cul-de-sac, named the "*foramen cæcum:*" it is occupied by a fold of pia mater. On each side of the fissure there stand out in relief three longitudinal eminences or columns. The middle ones are called the *anterior pyramids.* External to these are the *olivary bodies.* Still more external, and towards the posterior part of the medulla, are the *restiform* bodies; so called from their rope-like appearance. Let us examine each of these eminences in succession.

The *anterior pyramids,* so called from their shape, are narrow below, but gradually increase in breadth as they ascend towards the pons. The fibres of which they are composed are continuous with the anterior columns of the spinal cord, and consist, therefore, of motor fibres. They are a little constricted before they enter the pons, through which they may be traced into the lower part of the crura cerebri. By gently separating the pyramids from each other, about one inch below the pons, we observe that their fibres on each side decussate,—some passing above, others below those of the other side, so that they present an interwoven appearance. This decussation takes place only between the inner fibres of the pyramid; the outer fibres run straight on without decussating. Moreover, we shall presently find that these decussating fibres are prolongations of the deep fibres of the lateral columns of the cord which here come forward to the surface, pushing aside the proper anterior columns.*

The *olivary bodies* or *olives* are two oval eminences situated on the outer side of the pyramids, but not quite co-extensive with them. They consist externally of white substance; but when cut into, their interior presents an undulating line of grey matter, called, from its zig-zag shape, the *corpus dentatum.* This grey line forms a

* The decussation in question explains how it happens that, when an injury is done to one side of the brain, the disturbance of function is manifested on the opposite side of the body.

circuit, interrupted only on the inner side, so that it nearly isolates the white matter in its centre.

The *restiform bodies* are situated to the outer side of and behind the olives; therefore, to see them properly, we ought to look at the back of the medulla. There we observe that the restiform bodies diverge from each other, and pass into the cerebellum, constituting its inferior crura. In consequence of this divergence the grey matter in the interior of the medulla oblongata becomes exposed; therefore it is that the floor of the fourth ventricle is grey. The restiform bodies contain in their interior a considerable portion of grey matter, which is continuous with that in the posterior part of the spinal cord. The fibres of which they are composed are conductors of sensation.*

When a longitudinal section is carefully made through the middle of the pons and the medulla oblongata, a number of white fibres are seen passing in an horizontal direction, constituting a kind of septum between the two halves. Some of these septal fibres issuing from the anterior fissure wind round the sides of the medulla, and constitute what are termed the *arciform fibres* of the medulla: others, again, issuing from the posterior fissure, and winding round in a similar manner, form the transverse fibres seen on the floor of the fourth ventricle.

ARTERIES OF THE BRAIN.—The brain is supplied with blood by the two internal carotid and the two vertebral arteries.

The *internal carotid* enters the skull through a canal in the petrous portion of the temporal bone, mounts up very tortuously in a groove by the side of the body of the sphenoid, and, after giving off the ophthalmic, divides into the anterior and middle cerebral arteries, for the supply of the anterior and middle cerebral lobes.

The *anterior cerebral* artery sinks into the longitudinal fissure

* There are two slender columns marked off from the back part of the restiform bodies, one on either side the median fissure. These are the *posterior pyramids* of some anatomists. They proceed with the restiform bodies to the cerebellum.

between the hemispheres, curves round the front part of the corpus callosum, and then runs backwards along the upper surface of it. It distributes branches in all directions. The anterior cerebral arteries of opposite sides run close together, and at the base of the brain are connected by a short branch called the *anterior communicating.*

The *middle cerebral* artery runs deeply along the fissure of Silvius, distributing numerous and large branches to the anterior and middle lobes.

The *vertebral* artery, after winding backwards along the arch of the atlas, enters the skull through the foramen magnum, and unites with its fellow at the lower border of the pons to form the *basilar.* This single vessel proceeds along the middle of the pons, and divides at the upper border of it into the two posterior cerebral arteries for the supply of the posterior cerebral lobes.

In its course along the pons, the basilar ~~vertebral~~ gives off on either side—

- *a.* The *auditory* artery, which enters the meatus auditorius with the auditory nerve.
- *b.* The *superior and inferior cerebellar* arteries, for the supply of the upper and lower surfaces of the cerebellum.

Its terminal branches—the two *posterior cerebral*—run backwards, one on the under surface of each posterior cerebral lobe, dividing into numerous branches, which ultimately inosculate with the other cerebral arteries. But the principal inosculating branch of the posterior cerebral is called the *posterior communicating.* It proceeds straight forwards to the internal carotid, and thus establishes at the base of the brain that free inosculation of the large arteries which is called the "*circle of Willis.*"

The *circle of Willis,* then, is completed, in front, by the anterior communicating artery (between the two anterior cerebral), and behind by the posterior communicating (from the posterior cerebral to the carotid). The tortuosity of the large arteries before they enter the brain is obviously intended to mitigate the force of the heart's action; and the circle of Willis provides a free supply of

blood from all quarters, in case any accidental circumstance should stop the flow of blood in any one of the more direct channels.*

DISSECTION OF THE SPINAL CORD.

The proper mode of taking out the spinal cord is to saw through the arches of the vertebræ. When these are removed, the spinal cord, covered by its membranes, is exposed. The first thing we notice is, that the cord is far from occupying the whole area of the bony canal provided for its protection. The dura mater, here, does not adhere to the vertebræ, and is not their internal periosteum as it is in the skull. There intervenes between the bones and this membrane a space filled by a soft, reddish-looking, fat, and watery cellular tissue, and by the ramifications of a plexus of veins. A few words about these veins before we proceed.

Spinal system of veins.†—The spine is remarkable for the number of large and tortuous veins which ramify about it, both inside and outside the vertebral canal. One cannot form an adequate idea of them unless when properly injected. 1. There is a plexus of tortuous veins, both outside and inside the arches of the vertebræ. 2. Two large veins extend all down the spinal canal behind the bodies of the vertebræ; they communicate by cross branches, and receive the large veins which emerge from the can-

* In many of the long-necked herbivorous quadrupeds a beautiful provision has been made, in the disposition of the internal carotid arteries, for the purpose of equalising the force of the blood supplied to the brain. The arteries, as they enter the skull, divide into several branches, which again unite, so as to form a remarkable net-work of arteries, called by Galen, who first described it, the "*rete mirabile.*" The object of this evidently is to moderate the rapidity with which the blood would otherwise enter the cranium, in the different positions of the head, and thus preserve the brain from those sudden influxions to which it would under other circumstances be continually exposed.

† A very accurate description and representation of these veins has been given by Breschet, Essai sur les Veines du Rachis, 4to.; Traité Anatomique sur le Système Veineux, fol. avec planches.

cellous texture of the bones. 3. There are the proper veins of the spinal cord which lie within the dura mater. One and all discharge themselves through the intervertebral foramina in the several regions of the spine, as follows:—in the cervical, into the vertebral veins; in the dorsal, into the intercostal veins; and in the lumbar, into the lumbar veins. It deserves to be remarked that this complicate system of veins is wholly unprovided with valves; and hence it is that they are so liable to become congested in diseases of the spine.

The several membranes of the spinal cord, though continuous with those of the brain, yet differ from them in certain respects, so as to require a separate notice.

The *dura mater of the cord* is a tough fibrous membrane like that of the brain, but, as already observed, does not adhere to the bones of the spine, because such adhesion would obviously have impeded the free movement of the vertebræ upon each other. It forms a complete canal, which loosely surrounds the spinal cord, and sends off prolongations over each of the spinal nerves. These prolongations accompany the nerves only as far as the intervertebral foramina, and are then blended with the periosteum.

Cut through the several nerves which proceed from the spinal cord on either side, and remove it with its dura mater entire. The next proceeding is to slit up the dura mater along the middle line, in order to examine the arachnoid membrane.

The *arachnoid membrane of the cord* is a continuation from that of the brain. It is not in immediate contact with the pia mater underneath, but is separated from it by a transparent watery fluid contained in the meshes of the subarachnoid tissue; therefore the cord may truly be said to float in a fluid. This cerebro-spinal fluid cannot be demonstrated unless the spinal cord be examined very soon after death, and before the removal of the brain.* The nerves pro-

* The existence and situation of the cerebro-spinal fluid was first discovered by Haller (Element. Phys. vol. iv. p. 87), and subsequently more minutely investigated by Magendie (Récherches Phys. et Cliniques sur le Liquide Cephalo-rachidien, in 4to. avec atlas: Paris, 1842). This physiologist has shown that if, during life, the arches of the vertebræ are removed in a horse, dog, or other animal, and the dura mater of the cord punctured,

ceeding from the cord are loosely surrounded by a sheath of the arachnoid; but this only accompanies them as far as the dura mater, and is then reflected upon that membrane.

The *pia mater of the cord* is the membrane which immediately invests it. It is quite different from that of the brain, since it is not so much intended to nourish the nervous matter as to support it; consequently it is much less vascular, more fibrous in its structure, and more adherent to the subjacent proper substance of the cord. The longitudinal fibres of which it is composed are rendered very evident by immersion for a time in water. It is prolonged upon the spinal nerves, and forms their investing membrane or neurilemma.

The pia mater sends off from either side of the cord, along its whole length, a series of ligaments, in order to steady it. They are of a triangular shape, their bases being attached to the cord, and their sharp points to the inside of the dura mater. Thus they look something like a series of teeth down the side of the cord, and hence the name, *ligamentum dentatum,* given by anatomists to the entire apparatus. There are from eighteen to twenty-two of them on either side, and they generally lie between the anterior and posterior roots of the spinal nerves.

The SPINAL CORD is that part of the cerebro-spinal axis contained in the vertebral canal. It is the continuation of the medulla oblongata, and extends from the foramen magnum to about the

there issue jets of a fluid which had previously made the sheath tense. The fluid communicates, through the fourth ventricle, with that in the general ventricular cavity. The collective amount of the fluid varies from 1 to 2 oz. or more. There is little doubt that it can be made to move from the brain into the cord, or vice versâ. This is proved by experiments on animals, and by that pathological condition of the spine in children termed spina bifida. In the latter instance, coughing and crying make the tumour swell; showing that fluid is forced into it from the ventricles. Again, if pressure be made on the tumour with one hand, and the fontanelles of the child examined with the other, in proportion as the spinal swelling decreases so is the brain felt to swell up, accompanied by symptoms resulting from pressure on the nervous axis generally. See some remarks very much to the point, by Dr. Burrows, On Diseases of the Cerebral Circulation, p. 50, 1846.

upper border of the second lumbar vertebra, where it terminates in a pointed manner, after having given off the great bundle of nerves termed the "cauda equina" for the supply of the lower limbs.* The general form of the cord is cylindrical, slightly flattened in front and behind. It is not of uniform dimensions throughout, but presents a slight enlargement in the lower part of the cervical region, and another in the lower part of the dorsal, just where the great nerves of the upper and lower limbs are given off.

The cord is divided into two symmetrical halves by a fissure in front and behind. The *anterior fissure* is the most distinct, and penetrates about one-third of the substance of the cord; it contains a fold of pia mater full of blood-vessels for the supply of the interior. At the bottom of this fissure there is a transverse layer of white substance, named the *anterior commissure,* connecting the two anterior halves of the cord. The *posterior fissure* is so much less apparent than the anterior, that some anatomists altogether deny its existence; but it can be demonstrated by a careful preparation, and, indeed, penetrates to a greater depth than the anterior, so that it reaches quite down to the grey matter in the centre of the cord.

Besides the anterior and posterior fissures, there run down each half of the cord two very superficial grooves, from which the anterior and posterior roots of the spinal nerves respectively emerge. These constitute the *anterior* and *posterior lateral grooves.* The posterior leads down to the posterior horn of the grey matter in the interior of the cord; the anterior is less distinct than the other, and does not reach down to the anterior horn of grey matter. By these lateral grooves each half of the cord is divided into three longitudinal columns—an anterior, a posterior, and a lateral. The ante-

* Although the nerve-substance of the cord itself terminates at the second lumbar vertebra, yet the pia mater is continued as a slender filament, called the *filum terminale,* down to the base of the coccyx. The explanation of this is, that, at an early period of fœtal life, the length of the cord corresponds with that of the vertebral canal; but, after the 3d month, the lumbar and sacral vertebræ grow away, so to speak, from the cord, in accordance with the more active development of the lower limbs. See Tiedemann, Anatomie und Bildungsgeschichte des Gehirns im Fœtus des Menschen, &c., mit sieben tafeln; Nüremberg, 1816.

rior are motor columns, the posterior sensitive, while the lateral most probably contain both motor and sensitive filaments.

If we make a transverse section through the cord, we find that its interior contains grey matter, arranged in the form of two crescents placed one in each half of it, with their convexities towards each other, and connected across the centre by a portion called the *grey commissure.** The posterior horns of the crescents are long and narrow, and extend to the posterior lateral fissure, where they are connected with the posterior roots of the spinal nerves. The anterior horns are shorter and thicker, and come forwards towards the line of attachment of the anterior roots of the nerves, but do not quite reach the surface.

Spinal nerves.— Thirty-one pair of nerves arise from the spinal cord,—namely, 8 in the cervical region, 12 in the dorsal, 5 in the lumbar, 5 in the sacral, and 1 in the coccygeal. Each nerve comes off by two distinct series of roots,—one from the front, the other from the back of the cord. Experimental physiology proves that the anterior consists of motor filaments, the posterior of sensitive. All converge and unite in the corresponding intervertebral foramen to form a single nerve, composed of both motor and sensitive filaments.

The posterior or sensitive roots proceed from the posterior lateral groove of the cord, and are, upon the whole, thicker and more numerous than the anterior.* But the most remarkable thing about

* The grey matter in the interior of the cord of man and animals presents somewhat different appearances in its different parts. These have been accurately described and figured by Rolando, Richerche Anatomiche sulla Struttura del Midollo Spinale, con Figure, art. Tratto dal Dizionario Periodico di Medicina. Torino, 1824, 8vo. p. 55.

† The researches of Blandin, Anat. descript. t. ii., p. 648, 1838, have led him to establish the following relation between the respective size of the anterior and posterior roots of the nerves in the several regions of the spine :—

The posterior roots are to the anterior in the cervical region				: : 2	: 1
,,	,,	,,	,, dorsal ,,	: : 1	: 1
,,	,,	,,	,, lumbar and sacral	: : $1\frac{1}{2}$	: 1

This relation quite accords with the greater delicacy of the sense of touch in the upper extremity.

them is, that, previous to their union with the anterior roots, they are collected together and pass through a ganglion. This ganglion is of an oval form, and lies in the intervertebral foramen, just where the roots of the nerves pass through the dura mater.*

The direction and length of the roots of the nerves vary in the different regions of the spine, because the respective parts of the cord from which they arise are not opposite the foramina through which the nerves leave the spinal canal. In the upper part of the cervical region, the origins of the nerves and their point of exit are nearly on the same level; therefore the roots proceed transversely, and are very short. But as we descend from the neck, the obliquity and length of the roots gradually increase, so that the roots of the lower dorsal nerves are at least two vertebræ higher than the foramina through which they emerge. Again, since the cord itself terminates at the second lumbar vertebra, the lumbar and sacral nerves must of necessity pass down from it almost perpendicularly through the lower part of the spinal canal. To this bundle of nerves the old anatomists have given the name of *cauda equina,* from its fancied resemblance to a horse's tail.

In brief, then, it appears that the spinal cord consists of two precisely symmetrical parts, separated in front and behind by a deep median fissure; that the two parts are connected at the bottom of the anterior fissure by an anterior or white commissure—at the bottom of the posterior fissure by the posterior or grey commissure; that each part of the cord is divided into three tracts or columns of longitudinal nerve-fibres—an anterior, a posterior, and a lateral—the boundaries between them being the respective lines of origin of the roots of the spinal nerves; that the interior of the cord contains grey matter disposed in the form of two crescents placed with their convexities towards each other, and connected by a transverse bar of grey matter, which is the posterior commissure.

Arteries of the spinal cord.—The cord is supplied with blood by—1, the *anterior spinal* artery, which commences at the medulla oblongata by a branch from the vertebral of each side, and then runs

* The ganglia of the two last sacral nerves lie within the dura mater.

down the front of the cord, receiving accessory branches in its course from the vertebral, the intercostal, and the lumbar arteries. 2. The posterior spinal arteries, which proceed also from the vertebral, intercostal, and lumbar arteries, and ramify very irregularly on the back of the cord.

Minute structure of the spinal cord.—The examination of this subject is attended with so much difficulty and nicety, that much difference of opinion exists even among the best observers. One of the first questions which naturally arises is this—What becomes of the roots of the spinal nerves after they have entered the cord? The probable answer to it is as follows:—The anterior and posterior roots pass horizontally into the grey matter of the cord, but do not terminate in it. The fibres of the anterior roots then proceed in two directions; one set run across through the anterior commissure of the cord, and are continued upwards with the anterior columns of the opposite side; so that, in point of fact, the anterior commissure consists of the decussation of the anterior columns of the cord. The other set of fibres do not decussate, but run up directly with the lateral columns of their own side.

With regard to the posterior roots, they pass horizontally inwards through the posterior horn of the grey matter, and then ascend, chiefly with the posterior columns, but partly also with the lateral columns. Some of the fibres may even be traced through the grey commissure into the posterior column of the opposite side.

Another interesting question is—Do the roots of the nerves terminate near that part of the cord which they enter, or are they continued up through the cord to the brain? The great probability is, that at least most of them ascend to the brain, though they have not hitherto been traced there uninterruptedly. In support of this the old doctrine, Kölliker adduces the following reasons, against Volkmann, who advocates the other side of the question:—

1. It has been ascertained by accurate measurement in the human subject that the white substance of the cord gradually increases in its dimensions from below upwards, the enlargement in the lower cervical and dorsal regions being due to an increase of the grey matter in the interior.

2. The dimensions of the spinal cord opposite the second cervical vertebra, exclusive of the interior grey matter, may be estimated at about fourteen square lines. The aggregate dimensions of the roots of all the spinal nerves amounts to forty-five square lines; but after due allowance is made for the great reduction in size which the nerve-fibres undergo as soon as they enter the cord, these forty-five are brought down to twelve. If, then, this estimate be correct, it follows that the upper part of the spinal cord is large enough to comprise all the roots of the spinal nerves.*

MINUTE STRUCTURE OF THE MEDULLA OBLONGATA AND PONS VAROLII.—These are among the most complicate parts of the central nervous system. They contain white and grey matter,† intermixed in a very curious manner. The white matter consists in part of a continuation of the longitudinal fibres of the cord, in part of a new system of horizontal fibres. We will endeavour to trace the longitudinal fibres first, and then the horizontal ones.

The *anterior columns of the cord*, having reached the lower part of the medulla oblongata, are not continued straight up through it, but diverge from each other, so as to allow a part of the lateral columns to come forward, and, after decussation, to form the pyramids. In their further progress the fibres of the anterior columns are disposed of thus: a small number of them run up and contribute to form the outer portion of their own pyramid; all the rest, after embracing the olive, pass up through the deep strata of the pons, and then divide into two bundles; one of these, called the fillet of Reil, mounts over the superior crus of the cerebellum to the corpora quadrigemina, beneath which it meets with the corre-

* Those who desire to follow up the subject will find the argument fully described in Volkmann's article "Nervenphysiologie," in Wagner's Handbuch der Phys.; in Kölliker's Mikroscopische Anatomie—Leipzig, 1850; and in Stilling and Wallach, Untersuchungen über die Textur des Rückenmarks—Leipzig, 1842.

† The grey matter in the medulla oblongata is collected in three situations —1. In the olives; 2. In the restiform tracts; 3. On the floor of the fourth ventricle.

sponding fillet of the opposite side; the other proceeds along the upper part of the crus cerebri to the cerebrum.

The *lateral columns of the cord* on reaching the medulla oblongata are disposed of in three ways, as follows:—Some of its fibres come forward between the diverging anterior columns, decussate in the middle line, and then form the pyramid of the opposite side; others ascend with the restiform tract into the cerebellum; a third set ascend along the floor of the fourth ventricle* (concealed by its superficial grey matter), and then along the upper part of the crus cerebri into the cerebrum.

The *posterior columns of the spinal cord,* ascending under the name of the restiform tracts at the back of the medulla oblongata, diverge from each other, and are, for the most part, continued into the cerebellum, forming its inferior crura; but some of their fibres run on along the floor of the fourth ventricle (external to the fibres from the lateral columns), and then along the upper part of the crura cerebri into the cerebrum.

The *horizontal fibres* in the medulla oblongata and the pons were first accurately described and delineated by Stilling.† Some of them form a sort of raphé, and divide the medulla oblongata and pons into symmetrical halves; others, arising apparently from the raphé, pass outwards in an arched manner through the lateral halves of the medulla; so that, when seen in a transverse section by transmitted light, they describe a series of curves, with the convexity forwards, throughout the entire thickness of the medulla. Some of these transverse fibres appear on the surface over the pyramid and the olivė; these have received the name of *arciform fibres (propons* or *ponticulus).* It is difficult to determine the object of this system of transverse fibres, or what parts they connect. Stilling and Kölliker,‡ who have deeply studied the subject, are both of opinion that they originate in the restiform tracts, and thence arch

* These fibres constitute what are sometimes called the "round cords" of the fourth ventricle.

† Ueber die Medulla Oblongata. Erlangen, 1843.

‡ Mikroscopische Anatomie, p. 454.

forwards,—some on the surface, others through the substance of the medulla, and that they eventually join the fibres of the raphé.

Internal structure of the pons Varolii.—The pons consists of transverse and longitudinal white fibres, with a considerable quantity of grey matter in its interior. The superficial layer of fibres is obviously transverse, and connects the two wings of the cerebellum. After removing this first layer, we come upon the longitudinal fibres of the pyramids in their course to the crura cerebri: these longitudinal fibres, however, are intersected by the deep transverse fibres of the pons, which, like the superficial ones, are continued into the cerebellum. The third and deepest layer of the pons consists entirely of longitudinal fibres, derived partly from the olivary or motor, partly from the restiform or sensitive tracts of the medulla oblongata. The septal fibres of the pons have been already alluded to in the preceding paragraph.

Crura Cerebri.—These are composed of longitudinal fibres, derived from the pyramids, from part of the lateral and restiform columns of the cord, and from the grey matter in the pons Varolii. If one of the crura be divided longitudinally, we find in the middle of it a layer of dark-coloured nervous matter, called the *locus niger;* it separates the crus into an upper and a lower stratum of fibres. The lower stratum is tough and coarse, and consists of the continuation of the fibres proceeding from the pyramid and the pons. The upper stratum is much softer and finer in texture, and has received the name of the *tegmentum:* it is composed of the fibres proceeding from the lateral and the restiform columns, and also from the superior commissure of the cerebellum.

Tracing the fibres of the crus cerebri onwards into the cerebral hemisphere, we find that they diverge from each other, that its lower fibres ascend chiefly through the corpora striata, its upper fibres through the thalami optici. In passing through these great ganglia, the crus receives a very large addition to its fibres: these then branch out widely towards all parts of the hemisphere, in order to reach the cortical substance on the surface.

From what has been said, it appears that the crura or roots of

the cerebellum and the cerebrum contain part of the motor and part of the sensitive tracts of the spinal cord.

Origin of the cerebral nerves.—The cerebral nerves are given off in pairs, named the first, second, third, &c., according to the order in which they appear, beginning from the front. There are nine pair. Anatomists, however, differ as to their classification. Some are nerves of special sense,—as the olfactory, the optic, the auditory; others are nerves of common sensation,—as the large root of the fifth, the glossopharyngeal, and the pneumogastric; others, again, are nerves of motion,—as the third, the fourth, the small root of the fifth, the sixth, the facial division of the seventh, the spinal accessory, and the ninth.

First pair, or olfactory nerve.—This nerve arises by three roots, —an outer and an inner, composed of white matter, and a central, composed of grey.

The outer white root proceeds from the bottom of the fissure of Silvius, and describes a curve with the concavity outwards.

The inner white root is shorter than the other, and arises from the posterior extremity of the internal convolution of the anterior cerebral lobe.

The middle or grey root arises from the posterior extremity of the furrow in which the olfactory nerve is lodged : to see it, therefore, we should turn the nerve backwards.

The olfactory nerve is triangular, that it may more conveniently fit into a furrow between the convolutions, and therefore be less exposed to the pressure of the brain. It proceeds nearly straightforward under the anterior lobe, and terminates in the olfactory ganglion, which lies on the cribriform plate of the œthmoid bone.

The olfactory ganglion is of an olive-like shape, of a reddish grey colour, and very soft consistence. It gives off from its under surface the true olfactory nerves.* For the description of these, see Head and Neck, § 237.

* Strictly speaking, the olfactory nerve and its ganglion are integrant parts (the prosencephalic lobe) of the brain. What in human anatomy is

Second pair, or optic.—These nerves arise from the corpora quadrigemina. They wind round the crura cerebri to the base of the brain, and, uniting in the middle line, constitute the optic commissure. This commissure rests on the sphenoid bone, just in front of the sella turcica, and rides as it were upon the tuber cinereum. From the commissure each nerve passes through the foramen opticum into the orbit, and terminates in the retina.

At the commissure some of the nerve fibres cross from one side to the other. This decussation affects only the fibres of the inner half of the nerve; those of the outer half keep to their own side. The purpose of this partial crossing is not thoroughly understood. It was ingeniously supposed by Dr. Wollaston* to account for single vision, since the right halves and the left halves of the eyes would derive their nerve-fibres from the same optic nerve.

Third pair, or motores oculorum.—The apparent origin of the third nerve is from the inner side of the crus cerebri, immediately in front of the pons; but its roots penetrate into the crus as deep as the locus niger. It passes through the sphenoidal fissure, and supplies all the muscles of the eye, except the superior oblique and the rectus externus.

Fourth pair, or pathetici.—This nerve arises from the valve of Vieussens. It runs transversely outwards, then winds round the crus cerebri, enters the orbit through the sphenoidal fissure, and supplies the superior oblique muscle of the eye.

Fifth pair, or trigeminal nerve.—This large nerve arises by two roots of very unequal size. The apparent origin of both is

called the origin of the nerve is, in point of fact, the crus of the olfactory lobe, and is in every way homologous to the crus cerebri or cerebelli. In proof of this, look at the enormous size and connections of the crus in animals which have very acute sense of smell. Throughout the vertebrate kingdom there is a strict ratio between the sense of smell and the development of the olfactory lobes. Again, in many animals these lobes are actually larger than the cerebral, and contain in their interior a cavity which communicates with the lateral ventricles. According to Tiedemann, this cavity exists even in the human fœtus at an early period.

* Philosophical Transactions of the Royal Society, 1824.

from the side of the pons; but their real origin is much deeper. The smaller and more anterior of the two, consisting of motor fibres only, may be traced into the pyramidal tract in the pons; the posterior and larger root, consisting of purely sensitive fibres, may be traced into the restiform tract of the medulla oblongata. The nerve proceeds forwards over the apex of the petrous portion of the temporal bone; and here there is developed upon the sensitive root the great *Gasserian* ganglion. This root then divides into three branches; the ophthalmic, which passes through the orbital fissure; the superior maxillary, which passes through the foramen rotundum; and the inferior maxillary, which passes through the foramen ovale. They all confer common sensibility upon the parts they supply, which comprise nearly the entire head. The small motor root accompanies the inferior maxillary division of the sensitive root, and is distributed to the muscles of mastication.

Sixth pair, or abducentes.—This nerve arises from the medulla oblongata, close to the pons, leaves the skull through the sphenoidal fissure, and supplies the rectus externus muscle of the eye.

Seventh pair.—This consists of two distinct nerves—the *portio dura*, or muscular nerve of the face, and the *portio mollis*, or proper auditory nerve. The apparent origin of both is from the lower part of the pons Varolii. The real origin of the portio dura is in the lateral columns (motor) of the medulla oblongata. The real origin of the auditory nerve is from the floor of the fourth ventricle by several filaments. The seventh pair emerges from the skull through the meatus auditorius internus. For the further description of the portio dura, see Head and Neck, § 224. The auditory nerve is distributed to the internal ear.

Eighth pair.—This comprises three nerves—the glosso-pharyngeal, the pneumogastric, and the nervus accessorius. The first two arise by several filaments from the restiform column of the medulla oblongata, close to the olive. The nervus accessorius arises by a series of roots from the lateral column of the spinal cord, as low down as the fifth cervical nerve. It then ascends into the skull through the foramen magnum, and leaves it, with the other two nerves, through the foramen jugulare. The glosso-pharyngeal is

distributed to the mucous membrane of the pharynx and the back of the tongue. The pneumogastric is distributed to the pharynx, the larynx, the heart and lungs, the œsophagus, and the stomach. The nervus accessorius supplies the sterno-mastoid and the trapezius muscles. For the further description of these nerves, see Head and Neck, § 218.

Ninth pair, or hypoglossal.—This nerve arises by several roots from the medulla oblongata, close to the side of the pyramid. It leaves the skull through the anterior condyloid foramen, and is distributed to the muscles of the tongue.

DISSECTION OF THE EYE.

Since the human eye cannot be obtained sufficiently fresh for anatomical purposes, we must have recourse to the eyes of animals, —say of the sheep or the pig. The first thing to be done is to remove the conjunctival coat, together with the loose cellular tissue which unites it to the sclerotica.

Membrana conjunctiva.—This is the mucous membrane which lines the eyelids, and is reflected over the sclerotic coat of the eye by a loose fold, so as not to impede the motions of the globe. The palpebral portion of it is very vascular, and provided with fine papillæ.* The ocular portion has no papillæ, and is nearly colourless, except when inflamed; it then becomes intensely vascular and red, like a piece of scarlet cloth. An abundant supply of nerves has been bestowed upon the membrane for the purpose of giving it that exquisite degree of sensibility necessary to guard the eye.

A thin layer of conjunctiva covers the cornea or transparent part of the eye. True, it cannot be separated by dissection in recent eyes; but the corneal conjunctiva possesses the same acute sensibility as the rest of it; changes produced by inflammation of the

* These papillæ were first pointed out by Eble, Ueber den Bau und die Krankeiten des Bindehaut des Auges.

conjunctiva are often continued over the cornea: we see red vessels injected on its surface, and its texture becomes thickened.*

The human eye is very nearly spherical. It would be quite so, but that the transparent part in front—the cornea—forms a segment of a smaller sphere than the rest. Consequently, the antero-posterior diameter of the ball exceeds the transverse by about one line. The convexity of the cornea, however, varies in different persons, and at different periods of life; and this is one cause of the several degrees of near-sight and far-sight.

The globe is composed of coats arranged one within the other. The external coat, called the sclerotic, is fibrous, thick, and strong, so as to form, as it were, a case to protect the delicate structures within it. The second coat, called the choroid, is composed almost entirely of blood-vessels, and very dark in colour. The third coat is called the retina, and consists, in fact, of the expansion of the optic nerve for the reception of the impression of light. The great bulk of the interior is filled with a transparent humour called the vitreous. Imbedded in the front of this, and just behind the pupil, is the crystalline lens for the purpose of concentrating the rays of light. In front of the lens is placed a moveable curtain, called the iris, in order to regulate the quantity of light which shall be admitted through the pupil. The space in which the iris is suspended is filled with a fluid termed the aqueous humour.

Sclerotic coat.—This is the tough protecting coat of the eye, and consists of glistening fibres interlacing in all directions.† It

* The facts of comparative anatomy confirm this view. In the serpent tribe, which annually shed their skin, the front of the cornea comes off with the rest of the external surface of the body. In the eel the surface of the cornea is often drawn off in the process of skinning. In some species of rodents which burrow under the ground like the mole, the eye is covered with hair like other parts.

† The sclerotic coat of the eye in fishes is of extraordinary thickness and density, for obvious reasons; and in birds this coat is further strengthened by a circle of bony plates, fourteen or fifteen in number, arranged in a series round the margin of the cornea. Similar plates are found in some of the reptiles, and particularly in the fossil icthyosauri and plesiosauri.

covers about four-fifths of the globe, the remaining one-fifth being completed by the cornea. The thickest part of the sclerotic coat is at the back of the globe: here it is perforated by the optic nerve a little on the nasal side of the axis of vision;* and around the optic nerve it is also perforated by the ciliary arteries, veins, and nerves, for the supply of the choroid coat and the iris. Towards the front the sclerotic becomes much thinner, and about a quarter of an inch from the cornea it receives the insertion of the recti muscles; and here again it is perforated by the anterior ciliary arteries which creep along the tendons of these muscles.

In order to examine the cornea, it should be removed with the sclerotic coat. This is best done under water, by making a circular cut with scissors about a quarter of an inch from the margin of the cornea. With a little care, it is easy to take off the outer covering of the eye without injuring the dark choroid coat underneath it, or the ciliary ligament, or the iris. In the loose watery cellular tissue between the sclerotic and the choroid we observe the ciliary nerves coming forwards towards the iris: their white colour makes them very conspicuous on the dark ground.

Cornea.—This is the brilliant and transparent coat which occupies about one-fifth of the front part of the globe, and is, as it were, the window of the eye. However delicate it appears at first sight, yet it is quite as tough and thick as any part of the sclerotica. It is connected to this coat in the firmest possible manner: the margin of the sclerotica is bevelled off on the inside; that of the cornea on the outside; so that the one overlaps the other.

As to the structure of the cornea, it consists of concentric layers of transparent tissue, and, by squeezing it between the finger and thumb, we can make the layers glide on each other. But these layers are not all made up of the same kind of tissue. The first stratum is conjunctival; and of this sufficient mention has already been made. The second stratum consists of a remarkably elastic

* The optic nerve does not pass through a single large hole in the sclerotic, but through a kind of net-work of fibrous tissue. It is also very much constricted just at its entrance.

tissue. The third stratum consists of a kind of fibrous tissue, and upon this the thickness and strength of the cornea mainly depend. The fourth* stratum is again elastic. The fifth and last stratum consists of epithelium. Such is the beautiful structure of the cornea. In its healthy state it contains no blood-vessels; they run back in loops as soon as they reach its circumference.†

Choroid coat.‡—After the removal of the sclerotic and cornea, we expose the choroid coat,—a white ring, called the ciliary ligament, which bounds its anterior part, and also the iris, of which the outer circumference is attached to this ring.

The choroid is the soft and flocculent tunic of the eye, remarkable for its dark colour and great vascularity. When properly injected, and examined with the microscope, it is found to consist almost wholly of arterial and venous ramifications; the arteries being chiefly arranged on the inner, the veins on the outer surface. The dark colour is quite adventitious, and is owing to a deposit in its texture of colouring matter termed pigmentum nigrum.

The veins of the choroid, as already observed, are placed on the outside of the membrane. When successfully injected with mercury, one finds that they are arranged with great regularity in drooping branches, like a weeping willow, and that they converge to four nearly equidistant trunks, which, after running backwards for a short distance, perforate the sclerotica not far from the entrance of the optic nerve, and empty themselves into the opthalmic vein.

The arteries ramify on the inner surface of the choroid: they

* The great peculiarity of this layer is, that it is perfectly structureless; and when peeled off, it has a remarkable tendency to curl up. Maceration or boiling, or the action of acids, do not render it opaque, like they do the other layers of the cornea. Dr. Jacob calls it the "elastic cornea."—Med. Chir. Trans., vol. xii. p. 503.

† For a very elaborate investigation of the structure of the cornea, see Todd and Bowman's Physiological Anatomy, Part iii. p. 17.

‡ So called because its outer flocculent surface somewhat resembles the chorion or external investment of the ovum.

perforate the sclerotica near the optic nerve, and then divide and subdivide into a very minute network.*

Posteriorly there is a circular aperture in the choroid for the passage of the optic nerve. In front the choroid is united to the ciliary ligament: it appears to stop short here; but this is not the case; for, under this ligament, it extends forwards round the circumference of the crystalline lens in a series of plaited folds, called the ciliary processes.

Pigmentum nigrum.—This colouring matter is merely adventitious; for, if the choroid be washed for some time in water or spirit, the colour is entirely removed, leaving the membrane uninjured, and of a greyish tint. In man this pigment is dark brown, but in most animals it is jet black. Under the microscope, it is found to consist of coloured granules contained in minute hexagonal cells. It exists on both surfaces of the choroid, but chiefly on the inner, where it forms a continuous stratum.† The use of the pigment is to absorb the rays of light which pass through the retina, and prevent their being reflected. It serves the same purpose as the black paint with which the inside of optical instruments—*e. g.*, telescopes, cameræ obscuræ, &c.—is darkened. Albinos, in whom the choroid has little or no pigment, are consequently dazzled by daylight, and see better in the dusk.‡

Ciliary ligament.—This is a whitish grey ring, about one-

* This arterial network is sometimes called the "*tunica Ruyschiana,*" after Ruysch, who first injected it. The veins of the choroid are often called the "*vasa vorticosa.*"

† Dalrymple speaks of a very delicate membrane as lining the inner surface of the choroid, for the purpose of keeping the dark pigment in its place. A similar membrane may be detected on the posterior surface of the iris; otherwise the pigment there would be apt to be washed away by the aqueous humour.

‡ In many of the nocturnal carnivorous quadrupeds, the inner surface of the choroid at the bottom of the eye presents a brilliant colour and metallic lustre. It is called the tapetum. By reflecting the rays of light a second time through the retina, it probably causes the animal to see better in the dusk. It is the cause of the well-known glare of the eyes of cats and other animals; and the great breadth of the luminous appearance arises from the dilatation of the pupil.

eighth of an inch broad, situated just beneath the union of the sclerotica and the cornea. It serves as a connecting medium between several structures—namely, the choroid, iris, ciliary processes, and sclerotica.*

Iris.—This is a moveable curtain suspended freely in a clear fluid, which is situated in the space between the cornea and crystalline lens. The iris divides this space into two unequal parts, called the anterior and posterior chambers; and these communicate with each other through a circular aperture in the centre, called the pupil.† Its use is to regulate the amount of light which shall be admitted into the eye: for this purpose its inner circumference is capable of enlarging and contracting according to circumstances, while its outer circumference is immoveably connected to the ciliary ligament.

The colour of the iris varies in different individuals, and gives the peculiar tint and brilliancy to the eye. The colouring matter or pigment itself is contained in minute cells. The posterior surface of the iris, called the *uvea*,‡ is in all cases covered by a layer of black pigment.

When the iris is laid under water, and viewed with a low magnifying power, its front surface looks shaggy; a number of fine fibres are seen converging from all sides towards the pupil: many

* Some anatomists describe a *ciliary muscle.* They say its point of attachment is at the line of junction of the sclerotic and cornea; from thence it radiates backwards over the outer surface of the ciliary ligament, where its fibres are lost. Its action would be to approximate the ciliary processes and lens towards the cornea.

Sir Philip Crumpton has noticed that this muscle is well developed in birds. In them its fibres are of the striped kind, just as the circular fibres of the iris are.

† The size and shape of the pupil vary in different animals. In the bullock, sheep, horse, &c., it is oblong; in carnivorous quadrupeds it is often a mere vertical slit during the day, but dilates into a large circle at night.

‡ Strictly speaking, the term uvea was applied by the old anatomists to the choroid and iris collectively, which they very properly considered as one coat, and called the "χιτων ραγοειδης," because its dark colour made it like the berry of the grape.

of them unite and form arches. When the pupil is contracted these fibres are of course stretched, and *vice versâ*. Whether they co-operate in producing the dilatation of the pupil is uncertain.

The contractile power of the iris depends upon what are now generally admitted by anatomists to be muscular fibres of the non-striped kind, arranged in a radiating and circular manner. The radiating converge towards the pupil; the circular are aggregated round the pupillary margin.*

When minutely injected, the iris appears to be composed almost entirely of blood-vessels;† so much so that some anatomists consider it to be a kind of erectile tissue, and that its power of contracting and expanding depends upon this property alone. Its blood-vessels are derived from two sources—the posterior or long, and the anterior or short ciliary arteries. The posterior perforate the sclerotica round the optic nerve, and then run on upon the choroid to the iris; the anterior proceed from the tendons of the recti, and perforate the sclerotica round the margin of the cornea. It is from the enlargement of these latter vessels that the red zone round the cornea is produced in inflammation of the iris.

The nerves of the iris, twelve or thereabouts in number, proceed from the lenticular ganglion, and from the nasal branch of the ophthalmic division of the fifth pair. They perforate the back of the sclerotica like the arteries, and run along the choroid to the iris.

Until about the seventh or eighth month of fœtal life, the pupil is closed by a delicate membrane, termed "*membrana pupillaris.*" Its vessels are arranged in loops, which converge towards the centre of the pupil. It has been lately discovered that this membrane, which has always been regarded as a distinct structure, is

* The circular fibres of the iris in the bird are of the striped variety, and discernible without difficulty.

† In well-injected preparations one may see that the chief blood-vessels are disposed in two circles on the front surface of the iris—one near the outer, the other near the inner circumference.

identical with the anterior layer of the capsule of the crystalline lens.*

Retina.—To obtain a view of this membrane, the choroid coat must be removed while the eye is under water: this is readily done with the forceps and scissors. The optic nerve, having entered the interior of the globe through the sclerotic and the choroid membrane, expands into the delicate nervous tunic called the retina. In passing through the coats of the eye, the nerve becomes suddenly constricted, and reduced to one-third of its diameter: just at this point, too, it projects slightly into the interior of the globe, forming a little prominence to which the term "papilla conica" has been applied.† Anteriorly the retina terminates in a thin serrated border (ora serrata), which fits into corresponding dentations in the posterior margin of the ciliary body.

Precisely opposite the pupil there is a bright yellow spot in the retina, about 1-24th of an inch in diameter, fading off gradually at the edges, and having a black spot in the centre. This central spot was believed by its discoverer, the celebrated Soemmering,‡ to be a perforation; but it is now ascertained to depend upon the absence of the yellow colour in the centre; so that the dark pigment of the choroid becomes conspicuous. These appearances are lost soon after death, and are replaced by a minute fold, into which the retina gathers itself, reaching from the centre of the spot to the prominence of the optic nerve. The use of this yellow spot is not understood.§

Although to the naked eye the retina appears nothing more than a soft, semi-transparent, mucilaginous membrane, yet, when

* See a paper by John Quekett, in the Transactions of the Microscopic Society of London, vol. iii. p. 9.

† This prominence is remarkable, in that it is insensible to the rays of light.

‡ De foramine centrali, &c., retinæ humanæ; in Comment. Soc. Gotting. t. 13.

§ In birds the retina has throughout the yellowish colour seen only at one part in the human eye.

examined with the microscope, it is found to be most minutely and elaborately organised. The delicate fibres of the optic nerve spread out and ramify through a stratum of nerve-cells: how they ultimately terminate, whether by loops or in free extremities, is still doubtful. The ramifications of the arteria centralis retinæ form a close network of blood-vessels throughout the nervous substance, for its nutrition. After a short maceration in water, the nervous substance can be brushed off with a delicate camel's-hair pencil, and then, in an injected eye, the web formed by the vessels can be distinctly seen. The larger branches, however, are visible enough even without injection; and we observe that one of them runs quite round the free margin of the retina.

But the part of the retina most remarkable for the singularity of its organisation is the structure which forms its external layer. It is generally termed the "*membrana Jacobi*;"* and it certainly may be raised as an entire membrane by carefully injecting air beneath it while the eye is under water. When carefully examined with the high powers of a microscope, it is found to be composed of minute cylindrical, transparent, and highly refractive rods, arranged like the pile of velvet at right angles to the surface of the retina. Their outer extremities are imbedded, to a greater or less depth, in the dark pigment of the choroid; so that, when viewed from without, the rods have the appearance of a mosaic pavement.†

Ciliary body and processes.—These are best seen when the globe has been divided by a vertical section into an anterior and a posterior half, the vitreous humour being left undisturbed. We then see a beautiful black ring, about three lines broad, surrounding the lens: it may be regarded as a continuation of the choroid. The posterior boundary of this ring is smooth and flat, and defined by a dentated line. The anterior part presents a number of longitudinal plaits or folds, from sixty to seventy in number, alter-

* After its discoverer, Dr. Jacob, of Dublin, who described it in the Philosophical Transactions, 1819.

† See Hannover, Recherches Microscop. sur le Système Nerveux, 1844.

nately long and short, and arranged in a radiated manner round the circumference of the lens. The entire ring is called the ciliary body; and the folds of it in front, the ciliary processes. The processes are kept in place by being attached to the ciliary ligament: they fit into corresponding depressions in the vitreous humour, and their free ends project for a short distance into the posterior chamber. They consist of convolutions of minute arteries, and their dark colour arises from the pigment on their surface. Their use is unknown.

Chambers of the Eye.

Aqueous humour.—The aqueous humour consists of a few drops of clear watery fluid, which occupies the space between the cornea and crystalline lens. The iris floats freely in it, and divides the space into two compartments or chambers of unequal size—an anterior and a posterior. The posterior is much the smaller of the two: indeed, the iris is so close to the lens that they are separated by a mere film of fluid. This accounts for the frequent adhesions which are apt to take place, during inflammation, between the pupil and the capsule of the crystalline. Some anatomists describe the anterior chamber as lined by a serous membrane, which they call the membrane of the aqueous humour. It is true that there is a delicate layer of epithelium on the posterior surface of the cornea, but nothing like a continuous serous membrane can be demonstrated on the iris or the capsule of the lens. The anterior chamber is remarkable for the rapidity with which it absorbs and secretes, as is proved in the one case by the speedy removal of extravasated blood, and, in the other, by the rapid reappearance of the aqueous humour after the extraction of a cataract.

Vitreous humour.—This is a beautifully transparent, gelatinous-looking substance, which fills up nearly four-fifths of the interior of the globe. It consists of a watery fluid contained in the meshes of a cellular structure, called the "*hyaloid membrane*," from its perfect translucency: the cells communicate freely with

each other; for, if any part of it be punctured, the humour gradually drains off: the membrane itself is so delicate that it is difficult to obtain it separately; but it may be rendered slightly opaque by strong spirit or diluted acids. It is of somewhat firmer consistence on the surface, so that it answers the purpose of a capsule for the vitreous humour, and is sufficiently strong to keep it in shape after the stronger tunics of the eye have been removed.*

In the fœtus, a branch of the retinal artery runs up through the centre of the vitreous humour, and ramifies on the back of the capsule of the lens. It is lodged in a kind of tubular canal in the hyaloid membrane, termed the hyaloid canal; but little or nothing of this is seen in the adult.

The vitreous humour presents in front a deep depression, in which the crystalline lens is imbedded; and around this depression is what is called the "*zone of Zinn.*"† This zone is best exposed by peeling off the ciliary body, and washing away the pigment which it leaves behind. It extends from the indented margin of the retina nearly to the capsule of the lens: its surface is perfectly transparent, and presents a number of concentric folds, which correspond with those of the ciliary body. Various opinions are entertained of the nature of this zone; but, according to our observation, it does not appear to be anything more than the external surface of the hyaloid membrane.

Canal of Petit.‡—If the transparent membrane between the

* The cells of the vitreous humour may sometimes be demonstrated by freezing the eye and then dividing it. The figure and size of the cells is shown by the portions of ice which they contain. Again, by macerating the eye in chromic acid, it is found that the vitreous humour is intersected by 180 delicate partitions, disposed like those in the pulp of an orange—with this difference, however, that the partitions do not quite reach to the centre, but leave a cylindrical space in the axis of the humour. Up this space the central artery runs in the fœtus.

† Zinn was Professor of Anatomy at Göttingen about the middle of the eighteenth century, and author of "*Descriptio Anat. Oculi Humani.*"

‡ Petit, Mémoires de l'Académie des Sciences, 1723-1730.

zone of Zinn and the margin of the lens be carefully punctured, and the point of a small blow-pipe gently introduced, we may succeed in inflating a canal which encircles the lens, and, when inflated, resembles a circle of small glass beads: this is the canal of Petit, or "*canal godronné.*" How this canal is formed, whether by the separation of the hyaloid membrane into two layers or not, and what is its use, are questions not easily answered.

Crystalline lens.—This is a perfectly transparent solid body, situated immediately behind the pupil, and partly imbedded in the vitreous humour. It is convex on both surfaces, but more so behind. Its shape and consistence vary at different periods of life. In early life it is nearly spherical and soft, but it becomes more flattened and firmer with advancing age. In the adult, its transverse diameter is about three-eighths of an inch; its antero-posterior, one-sixth of an inch.

The lens is kept in place by a capsule equally transparent as itself. The capsule is composed of tissue exactly similar to the elastic layer of the cornea. It is at least four times thicker in front than behind, as one might expect, for the sake of more effective support. No vascular connection whatever exists between the lens and its capsule.* The lens protrudes directly the capsule is sufficiently opened. How, then, is the lens nourished? By means of an extremely delicate layer of nucleated cells on its surface, which absorb nourishment from the capsule. Some anatomists speak of a layer of fluid (liquor Morgagni) as existing between the lens and its capsule; but no such fluid can be detected during life, and, if there be any after death, it is, in all probability, imbibed by the capsule from the aqueous humour.

* The vessels of the capsule of the lens are derived from the arteria centralis retinæ, and, in mammalia, can only be injected in the fœtal state. In the reptilia, however, the posterior layer of the capsule is permanently vascular. According to Quekett, the membrana pupillaris of authors is nothing more than the anterior layer of the capsule. In taking the eye to pieces, it is quite a matter of accident whether the membrane adhere to the iris, or remain in its proper place in front of the lens. See Quekett's paper in the "Transactions of the Microscopic Society of London," vol. iii.

The minute structure of the lens is very remarkable. It is rather gelatinous in consistence at the outside, but grows gradually more dense towards the centre. After immersion in nitric acid, alcohol, or boiling water, it becomes hard and opaque. One may then see that it is imperfectly divided into three equal parts, by three lines which radiate from the centre to within one-third of the circumference. Each of these portions is composed of hundreds of concentric layers, arranged one within the other, something like the coats of an onion. But this is not all : if we examine any single layer with the microscope, we find that it is made up of fibres about 1-5000th of an inch in thickness, and connected together by finely serrated edges. This beautiful dovetailing of the fibres of the lens was first pointed out by Sir David Brewster ; and, to see it in perfection, one ought to take the lens of the common cod-fish.

DISSECTION OF THE ORGAN OF HEARING.

The parts constituting the organ of hearing should be examined in the following order :—1. The outer cartilage ; 2. The external meatus ; which leads to 3. The tympanum ; and lastly, the labyrinth, or internal ear, comprising the vestibule, cochlea, and semicircular canals.

Pinna.—Every one is familiar with the general form of the pinna, or fibro-cartilage of the ear ; but anatomists have given names to its different parts. The outer folded border is called the *helix ;* the ridge within it, the *ante-helix.* This bifurcates towards the front, and bounds the fossa of the ante-helix. The conical eminence in front of the meatus is termed the *tragus :* from this, hair generally grows. Behind the tragus, and separated from it by a deep notch, is the *anti-tragus.* The lobule is that part from which ear-rings are suspended ; and the deep hollow which collects the sonorous vibrations, and directs them into the meatus, is termed the *concha.* The groundwork of the pinna is a fibro-cartilage, which is attached by an anterior ligament to the zygoma, and by a posterior one to the mastoid process.

Muscles of the pinna.—The muscles which move the cartilage of the ear as a whole have been described in the dissection of the Head and Neck, § 181. Other little muscles there are which extend from one part of the cartilage to the other; but they are so indistinct, that, unless the body be very muscular, our attempt to find them will be made in vain. The five following are usually described by anatomists: four on the front of the pinna, and one behind it —

a. The *musculus major helicis* runs vertically along the front margin of the pinna.

b The *m. minor helicis* lies over that part of the helix which comes up from the bottom of the concha.

c. The *m. tragicus* lies vertically over the outer surface of the tragus.

d. The *m. anti-tragicus* proceeds transversely from the anti-tragus to the helix.

e. The *m. transversus* is on the back of the pinna: it passes from the back of the concha to the helix.

The arteries of the pinna are derived from the posterior auricular and the temporal. The nerves are furnished by the auriculo-parotidean branch of the cervical plexus, and the temporo-auricular branch of the inferior maxillary.

Meatus auditorius.—This passage leads down to the membrana tympani, or drum of the ear. It is formed partly by a tubular continuation of the concha, partly by an osseous canal in the temporal bone. It is not a straight tube, but inclines at first upwards and forwards, and then curves a little downwards.* Its length is rather more than an inch. It is not throughout of the same calibre; the narrowest part is about the middle: hence the difficulty in extracting foreign bodies which have gained access to the bottom of it. The true skin and the cuticle are continued down it; and, becoming gradually thinner, form a kind of cul-de-sac

* In order to obtain a correct knowledge of the length and dimensions of the meatus, we ought to make sections through it in different directions, or a cast of it in common plaister.

over the membrana tympani. Only the outer portion is furnished with ceruminous glands, of which the peculiar bitter secretion is for the purpose of keeping the passage moist, and preventing insects from lodging in it.

The *tympanum,* or middle ear, is an irregular cavity scooped out of the petrous part of the temporal bone, and lined by mucous membrane. It is filled with air, which is freely admitted through the Eustachian tube; so that the atmospheric pressure is equipoised on both sides of the membrana tympani. It contains a chain of small bones, of which the use is to communicate the vibrations of the membrana tympani to the internal parts of the ear. For this purpose one end of the chain is attached to the membrana tympani, the other to the fenestra ovalis. At the back part of it is an opening for the passage of air into the mastoid cells. Lastly, a nerve, called the chorda tympani (a branch of the portio dura) runs across it.

Membrana tympani.—We have already said that this membrane completely closes the bottom of the meatus auditorius. It is nearly circular, and its circumference is set in a bony groove, so that it is stretched somewhat like the parchment of a drum on the outer wall of the tympanum. Its plane is not vertical, but slants from above downwards, forming, with the lower part of the meatus, an angle of 45°: nor is it quite flat, but slightly conical, the apex being directed inwards towards the tympanum, and firmly united to the handle of the little bone called the malleus. The structure of the membrane is essentially fibrous; some of the fibres radiate from the centre, others are circular. Its inner surface is lined by mucous membrane; its outer surface is covered by an extremely thin layer of the true skin. This sufficiently accounts for the great sensibility of the membrane, and its vascularity when inflamed.

Eustachian tube.—For a complete account of this, see the dissection of the Head and Neck, § 157. We need only say here that it proceeds from the anterior part of the tympanum downwards and forwards to the pharynx.

Tympanic bones.—The four little bones in the tympanum are

named, after their fancied resemblance to certain implements, the *malleus, incus, os orbiculare,* and *stapes.* They are articulated to each other with perfect joints, and are so placed that the chain somewhat resembles the letter Z.* Their use is to transmit the vibrations of the membrana tympani to the membrane of the fenestra ovalis, and, through it, to the fluid contained in the internal ear. But they have another use, which would be incompatible with a single bone—namely, to permit the lightening and relaxation of the membrana tympani, and thus adapt it either to resist the impulse of a very loud sound, or to favour a more gentle one.

Muscles of the tympanum.—These little muscles, by moving the tympanic bones, tighten or relax the membrane of the tympanum. The *tensor tympani* runs above and parallel to the Eustachian tube, from the cartilaginous part of which it arises. It passes backwards, and terminates in a round tendon, which enters the fore part of the tympanum through a special bony canal, and is inserted into the short process of the malleus. Its action is to draw the membrana tympani inwards, and thus render it tense. The *laxator tympani* arises from the borders of the fissura Glasseri and is inserted into the long process of the malleus. The *stapedius* muscle arises from a tube in the pyramid, and its tendon is inserted into the neck of the stapes. Its precise use is not thoroughly understood.

The *chorda tympani* branch of the portio dura crosses the

* The handle of the malleus is nearly vertical, and attached along its whole length to the upper half of the membrana tympani. The long process (processus gracilis) projects at right angles from the body of the bone, runs into the Glasserian fissure, and receives the insertion of the laxator tympani. The short process receives the insertion of the tensor tympani.

The incus, or anvil bone, is shaped like a bicuspid molar tooth with unequal fangs. Its broad part articulates with the malleus ; its long process articulates with the stapes, or stirrup bone, through the os orbiculare ; its short process is directed backwards, and its point is fixed in a small hollow at the commencement of the mastoid cells.

The stapes is horizontal, and its base is attached to the membrane covering the fenestra ovalis.

tympanum between the handle of the malleus and the long process of the incus. See Head and Neck, § 224, *c*.

On the inner wall of the tympanum -that is, opposite to the membrana tympani—there are to be observed in the dry bone the following objects:—Beginning from above, there is an opening, called the *foramen ovale:* it leads into the vestibule of the internal ear, but is closed in the recent state by a membrane to which is attached the base of the stapes. Below the foramen ovale is a bony prominence called the *promontory.** Still lower is another opening, called the *foramen rotundum:* it leads into the tympanic scale of the cochlea, but is closed in the recent state by membrane. Immediately behind the foramen ovale is a small conical eminence, named the *pyramid:* there is a minute aperture in the summit of it, from which the tendon of the stapedius emerges. Lastly, at the back part of the tympanum is the opening which leads into the air-cells of the mastoid process.

The tympanum is supplied with blood by a branch of the internal maxillary, which runs in through the fissura Glasseri; 2. by the stylo-mastoid branch of the posterior auricular; 3. by small branches which enter with the Eustachian tube.

Internal Ear.—This, in consequence of its complexity, is very appropriately termed "the labyrinth." In a general way we may say that it consists of cavities excavated in the most compact part of the temporal bone. These cavities may be divided into three—a middle one, called "the vestibule," as being a centre in which all communicate with each other; an anterior, named, from its resemblance to a snail's shell, the cochlea; and a posterior, consisting of three semicircular canals. These cavities are filled with a clear fluid, called the endo-lymph, and contain a membranous expansion (the membranous labyrinth), upon which the filaments of the auditory nerve are expanded.

The *vestibule,* or central chamber, communicates in front with

* This promontory is occasioned by the first turn of the cochlea. Upon it ramifies the tympanic plexus of nerves formed by the sympathetic and the glosso pharyngeal.

the cochlea, through the scala cochleæ; behind, with the semicircular canals; on the outside, with the tympanum, through the foramen ovale; on the inside, with the bottom of the meatus auditorius internus.*

The *semicircular canals,* three in number, are situated above and rather behind the vestibule. Each canal forms the greater part of a circle, and opens at each extremity into the vestibule: therefore, there should be six apertures for them; but, in point of fact, there are only five, since one of the apertures is common to the extremity of two canals. The canals are not precisely of equal diameter throughout; each presents at one end a dilatation termed the "*ampulla.*" This dilatation is the most important part of the canal, because it corresponds to a similar dilatation of the membranous sac upon which the auditory nerve expands. Each canal differs in its direction: they are named accordingly *superior, posterior,* and *external.* The *superior* s. c. is also the most anterior of the three: its direction is vertical, and runs across the petrous bone: the ampulla is at the outer extremity. The *posterior* s. c. is also vertical, runs parallel to the posterior surface of the petrous bone, and, consequently, at right angles to the preceding: the ampulla is at the lower end. The *external* s. c. is horizontal in position, with the convexity of the arch directed backwards: the ampulla is at the outer end.

The *cochlea* is the most anterior part of the internal ear: it very closely resembles a common snail's shell, and is placed so that the base of the shell corresponds to the bottom of the meatus auditorius internus, while the apex is directed forwards and outwards. It consists of the spiral convolutious of two parallel and gradually tapering tubes. The partition by which they are separated is termed the "*lamina spiralis.*" In the dry bones this partition is only partial; but, in the recent state, it is completed by a membrane. At the very apex of the shell (helicotrema) the

* In some instances there is the opening of a small canal into the vestibule, termed the "aqueductus vestibuli." It leads to the posterior surface of the temporal bone, and contains a small vein.

partition is altogether absent, so that here the tubes communicate freely with each other. These tubes are called the scales of the cochlea, and are filled with fluid. The one opens freely into the vestibule, and is therefore called the vestibular scale; the other leads to the membrane which closes the foramen rotundum of the tympanum, and is termed the tympanic scale. If unwound, they would be about 1½ inch long. Each makes two turns and a half round a central pillar, from left to right in the right ear, and *vice versâ* in the left.

The central pillar of the cochlea is called the *modiolus.* It is of considerable thickness at the base, but gradually tapers towards the apex. Its interior is traversed by numerous canals, for the purpose of transmitting the filaments of the auditory nerve. One of these canals, larger than the others, runs down the centre of the modiolus nearly to the apex.

The *lamina spiralis*—which, as already observed, is nothing more than the partition between the two tubes or scales of the cochlea—is made up, on the inner half, of bone, on the outer half, of membrane. The bony part has a number of minute canals in it, which come off at right angles from the modiolus. They are for the special lodgement of the fine filaments of the auditory nerve in their course to the membranous part, which one can easily understand to be the most important element of the cochlea, since it receives the undulations of the fluid in the interior.*

The osseous labyrinth is lined throughout by a delicate fibro-serous membrane, which secretes the fluid called the "perilymph."

Membranous labyrinth.—If the bony labyrinth just now described be properly understood, we can have no difficulty in comprehending the membranous labyrinth in its interior—a structure

* There is an extremely delicate little muscle, termed the "cochlearis," for the purpose of tightening or relaxing, according to circumstances, the membranous part of the lamina spiralis. It is placed along the outer circumference of the membrane, and, in fact, forms an integrant part of it. Its fibres are of the non-striped kind, like the ciliary muscle of the eye. See Todd and Bowman, Phys. Anat. Part iii. p. 79.

intended to support the ultimate ramifications of the auditory nerve, and to expose them to the undulations of the fluid in the internal ear.

The membranous labyrinth, then, is nothing more than a sac, situated in the vestibule,* and from this there pass off three membranous semicircular canals within the bony ones. What was said of the bony canals applies equally to the membranous. They present the same dilatations or ampullæ at one end, and just at this part they nearly fill their bony cases; but in the rest of their extent the diameter of the membranous canal is not more than one-third that of the bony one.

The membranous labyrinth is protected inside and out by fluid. There is the proper fluid in the interior, termed the "endo-lymph," and the thin layer of fluid, the "peri-lymph," between it and the bone.

Distribution of the auditory nerve.—The auditory nerve, or portio mollis of the seventh pair, passes down the meatus auditorius internus, and, at the bottom of it, divides into an anterior and a posterior branch: in other words, a branch for the cochlea and a branch for the vestibule. These nerves then break up into numerous fasciculi, which pass through the foramina at the bottom of the meatus into the osseous labyrinth. Here the filaments are grouped into six bundles, corresponding to the parts which they supply—namely, two for the vestibular sac, one for each of the ampullæ of the semicircular canals, and one for the cochlea.

* Strictly speaking, the sac in the vestibule is constricted, so as to appear like two sacs of unequal size. The larger of the two is generally called the common sinus, is nearer to the semicircular canals, and communicates with them. The smaller, called the saccule, is nearer to the cochlea, and communicates with its vestibular scale. Both sacs are filled with the endo-lymph besides which, each contains a minute quantity of calcareous matter, called by Breschet the otolithes. These masses of cretaceous substance seem to be suspended in the fluid contained in the sacs by the intermedium of a number of nerve-filaments proceeding from the auditory nerve. From the universal presence of these chalky bodies in the labyrinth of all the mammalia, and from their much greater hardness and size in aquatic animals, there is little reason to doubt that they perform some office of great importance in the physiology of hearing.

The cochlear nerve divides into filaments, which run through the canals of the modiolus, and then along those of the lamina spiralis, in order to terminate upon the membranous part of this lamina. The precise manner in which the filaments terminate is still dubious: according to Breschet,* they communicate and form a series of minute arches.

Respecting the other nerves, little more need be said than that their ultimate ramifications are lost upon the vestibular sac and upon the ampullæ of the semicircular canals: some of them, however, pass into the sac, and come into contact with the otoconies, or ear-dust, in its interior.

The internal auditory artery—a branch of the basilar—runs with the auditory nerve to the bottom of the meatus, and divides into branches corresponding with the divisions of the nerve. Its ultimate ramifications terminate, in the form of a fine network, on the membranous labyrinth, and on the spiral lamina of the cochlea. The auditory vein pours its blood into the superior petrosal sinus.

DISSECTION OF THE MAMMARY GLAND.

The form, size, position, and other external characters of the mammary gland, are sufficiently obvious. We would merely observe that the longest diameter of the gland is in a direction upwards and outwards towards the axilla; that the thickest part is at the centre; and that the fulness and roundness of the gland depend upon the quantity of fat which is situated about it and between its lobes. Its deep surface is flattened in adaptation to the pectoral muscle, to which it is loosely connected by an abundance of cellular tissue.

It is inclosed by a fascia which not only supports it as a whole, but penetrates into its interior, so as to form a kind of framework for its several lobes: hence it is that, in cases of mammary abscess, the matter is apt to be circumscribed and not diffused.

* Recherches Anat. et Phys. sur l'Organe de l'Ouie, &c. (Mém. de l'Acad. de Med. t. v. fasc. iii. 1836).

The *nipple* projects a little below the centre; it is surrounded by a coloured circle termed the areola: this circle is of a rose-pink colour in virgins, but, in those who have borne children, of a dark brown. It invariably begins to enlarge and grow darker about the second or third month of pregnancy, and these changes continue till parturition. The areola is also abundantly provided with papillæ, and with a number of subcutaneous sebaceous glands, for the purpose of lubricating the surface during the sucking of the child.

The gland itself consists of distinct lobes held together by a firm cellular tissue, and provided with separate excretory or lactiferous ducts. Each lobe divides and subdivides into lobules, and the duct branches out accordingly.* If the ducts be traced to their origin, we find that they commence in clusters of minute cells, and that the blood-vessels ramify upon these cells in rich profusion: altogether, then, a single lobe might be rudely compared to a bunch of grapes, of which the stalk represents the main duct. The main ducts from the several lobes, from fifteen to twenty in number, converge towards the nipple, and, just before they reach it, become dilated into small sacs or reservoirs two or three lines wide; after this they run up to the apex of the nipple, and terminate in separate orifices.

The arteries of the gland are derived from the long thoracic and internal mammary: the nerves come from the cutaneous branches of the intercostal nerves.

DISSECTION OF THE SCROTUM AND TESTIS.

Immediately beneath the skin of the scrotum is a thin layer of contractile tissue, containing simple muscular fibres of the non-striped kind, like those of the bladder and intestines. It is termed the *tunica dartos scroti,* and may be regarded as a cutaneous mus-

* It is observed, in some cases, that one or more lobules run off to a considerable distance from the main body of the gland, and lie imbedded in the subcutaneous tissue. One should remember this when it is necessary to remove the entire gland.

cle, for the purpose of corrugating the loose and extensible integument, and, therefore, of supporting and bracing the testicles.

Beneath the dartos is the superficial fascia, consisting of a large quantity of loose cellular tissue, and remarkable for the total absence of fat: it forms a vertical partition between the testicles, called the *septum scroti*. This partition is not complete, since air or fluid will pass from one side to the other.

Beneath the superficial fascia is the *cremaster*, or suspensory muscle of the testicle. For a description of this, see Dissection of the Abdomen, § 9.

TESTIS.—The testicle is a gland of an oval shape, with flattened sides, suspended obliquely, so that the upper end points forwards and outwards, the lower end in just the reverse direction; the left is generally a little the lower of the two, for the purpose of obviating collision with its fellow. The ordinary weight of the gland is about six drachms, but few organs present greater variations in size and weight, even in men of the same age: generally speaking, also, the left is the larger. Along the posterior part of the gland is placed a long narrow body, termed the *epididymis:* this is not actually a part of the testicle, but rather an appendage to it, formed by the remarkable convolutions of its long excretory duct. Its upper larger end is called the globus major, and is connected to the testicle by the efferent ducts; the lower end, or globus minor, is only connected to the testicle by fibrous tissue.

We next come to speak of the proper coverings of the testicle. These are—1, a serous membrane, called the tunica vaginalis, to facilitate its movements; 2, a strong fibrous membrane, called the tunica albuginea, to support and form a case for the delicate glandular structure within; 3, a delicate stratum of minute blood-vessels, which some anatomists have described as a distinct coat under the name of tunica vasculosa.

Tunica vaginalis.—This is a serous sac, one part of which (tunica vaginalis propria) adheres closely to the testicle; the other (tunica vaginalis reflexa) is reflected loosely around it. If the sac be laid open, we then see that it completely covers the testi-

cle,* except behind, where the vessels and ducts enter; and that it also covers the epididymis on the outside entirely, but less so on the inside. The interior of the sac is smooth and polished, like all other serous membranes, and lubricated by a little fluid: an excess of this fluid gives rise to the disease termed hydrocele.

The tunica vaginalis was originally derived from the peritoneum. In some subjects it still communicates with that cavity by a narrow neck, and is therefore liable to become the sac of a hernia. Such herniæ are termed *congenital*—a bad name, since they do not, as a matter of course, take place at birth, but often in adult age. Sometimes the communication continues through a very contracted canal, open to the passage of fluid only; or the communication may be only partially obliterated, and then one or more isolated serous sacs are left along the cord. Such an one, when distended by fluid, gives rise to hydrocele of the cord.

Tunica albuginea.—This is a dense, inelastic membrane, composed of bundles of fibrous tissue, interlacing in every direction, analogous to the sclerotic coat of the eye. It completely invests the testicle, but not the epididymis. At the posterior part of the gland it penetrates into its substance for a short distance, and forms an incomplete vertical septum, termed, after the anatomist who first described it, the *corpus Highmori,* and subsequently, by Sir A. Cooper, the *mediastinum testis.* This septum transmits the blood-vessels of the gland, and contains, also, the net work of seminal ducts, called the rete testis.

From the mediastinum testis are given off in all directions a number of slender fibrous cords, which traverse the interior of the gland, and are attached to the inside of the tunica albuginea. They serve to maintain the general shape of the testicle, to support the numerous lobules of which its glandular substance is composed, and to convey the blood-vessels into it. These tie-beams (trabeculi

* Strictly speaking, the tunica vaginalis does not cover quite the lower part of the testicle: this uncovered part corresponds to the original attachment of the gubernaculum.

testis), as well as the mediastinum from which they proceed, are readily seen on making a transverse section through the gland.

Respecting the so-called *tunica vasculosa,* nothing more need be said than that it consists of a multitude of fine blood-vessels, formed by the ramifications of the spermatic artery, and held together by delicate cellular tissue. It lines the inner surface of the tunica albuginea, and gives off vessels which run with the fibrous cords into the interior of the gland.

Glandular structure.—When the testicle is cut into, its interior looks soft and pulpy, and of a reddish-grey colour. It consists of an innumerable multitude of minute convoluted tubes (tubuli seminiferi). For convenience of package, they are arranged in lobes, between four and five hundred* in number, of various sizes, and contained in the compartments formed by the fibrous cords proceeding from the mediastinum testis. Though disposed in lobes, still they communicate with each other, and thus form one vast network of tubes. The secretion from them is carried off by some forty or fifty straight vessels (vasa recta), which penetrate the mediastinum testis, and there form a plexus of seminal tubes, termed the *rete testis.* This lies along the back of the gland. From the upper part of the rete the secretion is carried away to the large end of the epididymis by means of fifteen or twenty tubes, termed *vasa efferentia.* These, after forming a vast number of coils, termed coni vasculosi, which collectively constitute the globus major of the epididymis, ultimately terminate, one after the other, in a single duct, the commencement of the vas deferens.

Commencing, then, in the globus major of the epididymis, the vas deferens descends, making a series of extremely tortuous coils, which alone form the globus minor.† From the lower part of the globus minor the vas deferens ascends, joining the other component parts of the spermatic cord, passes through the inguinal canal, winds round the back part of the bladder, and finally empties itself into

* This estimate is according to Krause, Müller's Archiv für Anat. 1837.

† A little blind duct, called *vasculum aberrans,* is sometimes connected either to the epididymis or the vas deferens.

the prostatic part of the urethra. The length of the vas deferens was estimated by Monro at upwards of thirty feet. The same anatomist calculated that the semen, before it arrived at the vas deferens, had to traverse a tube forty-two feet in length.

Spermatic cord.—This is composed of the spermatic vessels, nerves, and absorbents, of the vas deferens, with the little deferential artery (a branch of the superior vesical), of the cremaster muscle, with the cremasteric artery, and of the spermatic fascia.

The course of the spermatic arteries and veins has been described in the dissection of the Abdomen, § 35, *d.* We will only observe further that the artery is remarkably tortuous as it descends along the cord, that it enters the back part of the testicle, and breaks up into a multitude of fine ramifications, which spread out on the inner surface of the tunica albuginea. The spermatic veins leave the testicle at its back part, and, as they ascend along the cord, become extremely tortuous, and form a plexus termed "*pampiniform.*" It is usually stated that these veins are destitute of valves; and this fact is adduced as one of the reasons for the occurrence of varicocele. But it is certain that the larger veins do contain valves.

The *absorbents* of the testicle terminate in the lumbar glands.

The *nerves* of the testicle are derived chiefly from the renal plexus.

Descent of the testicles.—The testicle is originally situated and developed in the lumbar region, immediately below the kidneys; and it is loosely attached to the back of the abdomen by a fold of peritoneum, termed the *mesorchium,* along which its vessels and nerves run up to it, as to any other abdominal viscus. From the lower end of the gland there proceeds to the bottom of the scrotum a contractile cord termed the gubernaculum testis.* By the gradual contraction of this, the organ is brought into the scrotum. It begins to move about the fifth month, reaches the ring about the

* Mr. Curling considers the gubernaculum testis to be a muscular cord. See his Observations on the Structure of the Gubernaculum, and on the Descent of the Testis in the Fœtus: Medical Gazette, April 10, 1841.

seventh, and about the ninth has entered the scrotum. Its original peritoneal coat is retained throughout; but, as it enters the inguinal canal, the peritoneal lining of the abdomen is protruded before it, and eventually becomes the tunica vaginalis reflexa. Immediately after the descent of the testis, then, its serous bag communicates with the abdomen, and in the lower animals continues to do so through life.* But in the human subject the canal of communication soon begins to close; so that, before the end of the first month after birth, the canal is entirely obliterated from the abdominal ring to the testis. Sometimes, however, this obliteration fails to take place, or is only partial; hence may arise congenital hernia, or hydrocele of the cord.

* According to Professor Owen, the chimpanzee is the only exception to this rule.

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